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ABSTRACT

Described are 2,589 research projects under the general headings of: Properties of Water, Water Motion, Meteorology, Survey and Prediction, Living Systems (non-human), Public Health and Safety, Marine Geology, Engineering and Technology, Costal Zone Management and Use, Legal Studies, Education and Training, and Facilities. Each description outlines the objectives and approach of the project. The name of the principal investigator and the address of the institution are given, and supporting agencies are identified. There is a subject index, a principal investigator index, a contractor index, and a supporting agency index. (EB)

ED038314

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Marine Research

FISCAL YEAR 1968

**A Catalog of Unclassified Marine Research Activities
Sponsored During FY 1968 by Federal and
Non-Federal Organizations**

**Executive Office of the President
National Council on Marine Resources and Engineering Development**

July 1969

SE 008 277

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FOREWORD BY THE VICE PRESIDENT OF THE UNITED STATES

The establishment of a long-range program to utilize the oceans for the benefit of all mankind was set forth as a national policy by the Marine Resources and Engineering Development Act of 1966. Meeting marine science needs and opportunities in turn depends significantly upon a strong research capability. Such research encompasses a broad spectrum of disciplines in support of, among others, the development of living and non-living resources, environmental prediction, conservation and recreation, maritime commerce, and national security activities. While these endeavors are supported largely by the Federal Government, they are conducted in some 95 academic institutions; several hundred State and local organizations and laboratories; over 35 private foundations and professional associations; hundreds of industrial organizations; as well as in more then 85 Federal laboratories.

Maximizing benefits from the Nation's growing investment in the oceans requires developing the full potential of this widely dispersed research capability. Because of the very number and diversity of organizations and activities involved, however, there is a serious hazard of unwitting duplication or gaps in research efforts. Complete information about on-going research and effective information transfer thus become key elements for assuring that individual scientists, engineers, administrators, and policy officials have access to knowledge of "who is doing what, where, and with whose support."

Toward that end, the National Council on Marine Resources and Engineering Development is releasing this report: *Marine Research—Fiscal Year 1968*. The 2589 project descriptions contained herein should assist participants in Government, industry, and universities to select new areas for research, while avoiding wasteful duplication. By identifying individuals and organizations active in the same or closely aligned fields, communication of ideas, opinions, and data should be facilitated. And policy planning and decision making at all levels should be enhanced by the overview this compilation provides of the scope, balance, and texture of marine research.

Although invitations for contributions to the catalog were extended to over 400 non-Federal sponsors, this first national inventory of marine research still lacks information about many relevant non-proprietary projects. In addition, marine technology, ocean operations, and capital expenditures are not covered. It is hoped that among the benefits from this publication will be expanded recognition of the value of descriptive information about marine programs, and support for activities designed to improve the flow of information among specialists working in this area. I commend this report to all of those interested in the marine sciences—in their endeavors to help this Nation achieve the goals of more effective use of the seas.

Spiro T. Agnew

Spiro T. Agnew,
Vice President

INTRODUCTION

One facet of the United States' marine science program, set forth in the Marine Resources and Engineering Development Act of 1966 (PL 89–454), is:

> "The effective utilization of the scientific and engineering resources of the Nation, with close cooperation among all interested agencies, public and private, in order to avoid duplication of effort, facilities, equipment, or waste."

To fulfill its responsibility to assist the President with implementing the Act, the National Council on Marine Resources and Engineering Development has recognized that achievement of this objective depends critically upon the availability of comprehensive, definitive and timely information about the Nation's marine science activities and capabilities. Toward this end, the Council assigned to the Science Information Exchange (SIE) in April 1968 the responsibilities as a national center to collect and disseminate information about current, unclassified marine research. In October, the Council contracted with SIE for preparation of a catalog of marine research sponsored by the United States during fiscal year 1968.

Marine Research—Fiscal Year 1968 is the product of an inventory of Federal and non-Federal organizations with ocean-related research programs and interests. It contains descriptive summaries of 2,589 unclassified projects which were funded, either for the first time or as continuing efforts, during that fiscal year. Associated with these projects, and identified by name and address, are 3,022 investigators; 457 contractors; 25 Federal supporting agencies; and 95 non-Federal sources of support.

The projects referenced in the catalog cover basic and applied research on the marine environment and its resources. This environment is defined to comprise the oceans, the estuarine and coastal areas, and the Great Lakes. For purposes of project selection, contributors were requested to interpret the guideline definitions in a broad sense so that pertinent items would not be overlooked. Research on properties of saline water systems, the behavior of materials in seawater, and techniques of desalination sponsored by the Office of Saline Water is omitted because these data are presented in the annual *Water Resources Research Catalog* which SIE prepares for the Department of the Interior. In addition, the level of project funding is not presented in this first edition since it was absent on almost one-half of the marine research summaries registered at SIE.

It is hoped that the document will be of sufficient value to encourage users to maintain complete and current records of their projects at SIE, thereby providing a central source for comprehensive marine research information.

The catalog could not have been produced without the full cooperation of the Federal agencies and State and private institutions which reviewed, updated, and supplemented the records of their research on file at SIE. Special appreciation is extended to the many industrial organizations that provided project descriptions to SIE for the first time in support of this inventory. Finally, we wish to acknowledge the effort made by the Science Information Exchange in completing its work with skill and on schedule, and the direction of the project by Mr. Bill Long of the staff of the National Council on Marine Resources and Engineering Development.

EDITOR'S NOTE

On 30 April 1968, the National Council on Marine Resources and Engineering Development designated the Science Information Exchange of the Smithsonian Institution to be the national information center for unclassified, current marine science research information. Specifically, the Exchange undertook the responsibilities of a National Center for receiving, compiling, cataloging, and disseminating information concerning unclassified ongoing research and development activities in the Marine Sciences.

Marine Research—Fiscal Year 1968, prepared by the Science Information Exchange at the request of the National Council on Marine Resources and Engineering Development, is a part of this continuing mission in the marine information area. It provides information on 2,589 projects, supported by both Federal and non-Federal funds. In addition to projects registered with the Exchange, requests for ongoing research projects were made to some 385 non-Federal sources of marine research in an effort to supplement the non-Federal research already registered.

The research listed has been forwarded for inclusion by the supporting agencies. Frequently, more than one agency sponsored a single research project, sometimes resulting in the receipt of multiple records for the same research effort. If these project descriptions were essentially the same, only one was included in the document. However, all sources of support are identified for each project summary appearing in the catalog.

The projects included herein were reviewed, updated, and designated as marine research by the original source of material: Federal and state agencies, private industry, academic institutions, private foundations, or individual scientists. They were assigned to chapters and subchapters according to their subject matter. In addition to the summaries of the 2,589 projects, the catalog contains the following indexes: Subject Index, Investigator Index, Contractor Index, and Supporting Agency Index. The information which appears in the summaries and indexes was taken directly from the project records as received by the Exchange.

The Subject Index was developed by the Science Information Exchange. Each project has been indexed to an average of five terms which are arranged in hierarchies indicating relationships between broader and narrower concepts. The index term is followed by the project title, additional keywords used in indexing, and the chapter and subchapter number of the project. All terms were selected to emphasize the marine aspects of the project and are as specific as the language of the summary. A project which deals with "wave-built terraces" will be indexed to that specific term under a hierarchy consisting of the term "depositional features" and the still broader term "shorelines-geomorphic studies." Thus, one must turn to the high level term "shorelines-geomorphic studies" to find projects dealing with wave-built terraces, but he will also find all geomorphic shoreline studies grouped together in the same section. To further aid in locating subject areas, the first high level hierarchical term to appear on a left-hand Subject Index page is also printed in the upper left-hand corner of that page and the last high level term to appear on the right-hand page will also appear in the upper right-hand corner of that page in dictionary fashion.

The Supporting Agency Index consists of a single alphabetic listing of both Federal and non-Federal sources of support. In view of the large number of state agencies and departments, they are displayed as a combined group under each state. All investigators cited on the source document are included in the Investigator Index. An asterisk is used to designate the individual specified as principal investigator. However, in some instances it is apparent that the "principal investigator" denoted on the source document is, in fact, a program manager who is not working at the contractor location given in the project summary. The Contractor Index is an alphabetic listing of the performing organizations and their locations.

All of the indexes in this catalog were generated by means of a computer, necessitating a limitation on the number of characters available for index terms and captions. Thus, in some instances, abbreviations had to be used.

We hope that the users of the catalog will advise the Science Information Exchange of any errors of omission or commission that have been made. Also critiques of this volume are encouraged so that future editions might best reflect the information therein in a format and with indexes which are most convenient and acceptable to the user.

Monroe E. Freeman

MONROE E. FREEMAN, *Director*
Science Information Exchange

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DESCRIPTIONS OF RESEARCH PROJECTS

1. PROPERTIES OF WATER

(Studies In-Situ and of Saline Water Systems in Laboratory)

1A. ACOUSTICAL PROPERTIES

(see Chapter 7g For Acoustical Properties of Sediments)

1.0001, ARCTIC ACOUSTIC RESEARCH

B.M. BUCK, General Motors Corporation, *Goleta, California* 93017 (NONR)

A long term study of the properties of the ambient noise in the deep Arctic Basin will be studied with special interest in the effects of anisotropic noise field on the degradation of equipment. Propagation studies will continue.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0002, TURBULENCE STRUCTURE AND NOISE STUDY

E.R. VANDRIEST, North Amer. Rockwell Corp. , *Long Beach, California* 90803

The objective of this research project concerned the measurement of noise produced by turbulent flow as a function of flow projectries. The experiment utilized a pressure transducer located in the wall of a tubular fixture which was subjected to turbulent flow. The project also determined the reduction of such noise through the use of additives which were injected into the flow.

SUPPORTED BY North American Rockwell Corporation

1.0003, DETERMINANTS AND CONTROL OF UNDERWATER VOCALIZATIONS IN THE CALIFORNIA SEA LION

R.J. SCHUSTERMAN, Stanford Research Institute, *Menlo Park, California*

The purpose of this project is a delineation of the factors influencing the underwater vocalizations of a member of the pinnipeds, Zalophus californianus, the California sea-lion. A determination will be made of the degree to which these vocalizations can be utilized to communicate information from visual displays, e.g. different shapes and sizes of objects and patterns. Both the 'naturally' occurring vocalizations encountered in free-swimming situations and controlled vocalizations utilized for information transfer.

While a great deal of scientific and training effort has been placed upon the cetaceans, particularly the dolphins and porpoises, the pinnipeds, or seals and sea-lions have received little attention as to their capabilities and general biology. This project is one part of a program to provide such information on this group of highly adaptable and potentially valuable animals. The Navy should be aware of the physical parameters and behavioral patterns involved in the pinniped contribution to the oceanic acoustic ambient and the feasibility of utilization of these intelligent animals in similar supportive roles to those now filled by the porpoise.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0004, OCEAN DYNAMICS - OCEANOGRAPHIC ANALYSES AND FORECASTING MODELS

T. LAEVASTU, U.S. Navy, Postgraduate School, *Monterey, California* 93941

OBJECTIVE: To determine those environmental factors affecting acoustical uses of the ocean. Categorize strategic areas into similar acoustical provinces for sonar operation. To provide scientific acoustical synoptic oceanographic analyses/forecasting models.

APPROACH: Extrapolate and interpolate the oceanographic and acoustic properties of known to unknown areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0005, OCEANOGRAPHIC RESEARCH

Y. IGARASHI, U.S. Navy, Undersea Warfare Center, *Pasadena, California* 91107

Technical Objectives: To conduct an oceanographic research program that will provide an understanding of the effects and limitations imposed by the marine environment on the performance of weapons and weapon systems and the discovery of information which may lead to new concepts.

Approach: An applied research program is being pursued, keyed to acoustic problems in shallow waters. Two related areas are being investigated: (1) spatial dependence of temperature and sound velocity structures in water masses and (2) bottom characteristics at specific frequencies. To obtain basic data on temperature structure, a measurement program has been set up which requires simultaneous measurements at three stations using precision sensors. Physical measurements will be correlated with acoustic propagation tests; an improved theoretical model will be used to compute the intensities. A program has been formulated on the investigation of the relationship between bottom structures, and reflectivity and scattering at specific frequencies. Two reference areas having contrasting geological (and acoustic) properties were selected off the Southern California Coast for extensive oceanographic and supporting acoustic measurements.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0006, OCEANOMETRICS

E.R. ANDERSON, U.S. Navy, Undersea Warfare Center, *San Diego, California* 92140

Objective: To determine those environmental factors affecting acoustical uses of the ocean; to extrapolate and interpolate the oceanographic and acoustic properties of known to unknown areas; to develop theory for predicting the effects of variability of three layers of the sea; develop theory and models for predicting underwater sound propagation; develop statistical, physical and computer techniques.

Approach: Employ oceanographic, statistical, and computer concepts and techniques to develop new approaches for analyzing, summarizing, interpreting and extrapolating oceanographic data in ways meaningful to the scientist, engineer and officer dealing with underwater acoustic propagation research and equipment design and operation. Study the temporal and spatial variation of sound velocity and other pertinent oceanographic variables and their effect on sound propagation.

Make studies and investigations to describe space/time distributions of environmental factors; regional studies of same;

verification of theoretical work in dynamic oceanography and statistics; computer programs; special support of laboratory problems.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0007, MEASUREMENT AND PREDICTIVE STATISTICS OF REVERBERATION

W.E. BATZLER, U.S. Navy, Undersea Warfare Center, *San Diego, California* 92140

Objective: To acquire and organize information on underwater acoustic reverberation and on the mechanisms controlling back-scattered sound.

Approach: The approach encompasses studies of all factors affecting reverberation. These include the sea surface, wind speed, structure and composition of ocean bottom, scattering layers, other biological scatterers, etc.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0008, MEASUREMENT AND THEORY OF SCATTERED UNDERWATER SOUND

L.R. DUYKERS, U.S. Navy, Undersea Warfare Center, *San Diego, California* 92140

Objective: To study and explain theoretically the reasons for reflection losses and other propagation phenomena in the ocean.

Approach: The approach will include both experiment and theory. Much of the experimental data will be acquired in connection with propagation studies.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0009, OCEANOGRAPHIC RESEARCH-INVESTIGATIONS IN SHALLOW WATER

O.S. LEE, U.S. Navy, Undersea Warfare Center, *San Diego, California* 92140

Objective: To determine those environmental factors affecting acoustical uses of the ocean; investigate factors in physical oceanography which pertain to underwater sound including physical properties such as thermal structure, water motion; and chemical properties such as salinity and oxygen.

Approach: By use of the NUWC Oceanographic Tower, SCUBA, buoys and bottom mounted equipment, and shallow submersibles: observe, measure, correlate those properties in the surface layers of the sea affecting underwater sound, particularly the marine physical chemical, biological and geological near-shore properties. Develop environmental models for visibility, turbidity, conductivity, tidal and long shore currents, orbital motion, surface and internal waves, gas content and biological population, acoustical and chemical properties, bottom, beach and delta conditions, physical properties of sediments and microtopography; and instrumentation needed to obtain these models.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0010, DEEP OCEAN ACOUSTIC RESEARCH

K.V. MACKENZIE, U.S. Navy, Undersea Warfare Center, *San Diego, California* 92140

Objective: To determine those environmental factors affecting the acoustical uses of the ocean. Observe and develop theory and models for predicting underwater sound propagation using deep water paths, including near bottom phenomena; conduct underwater acoustic studies by utilizing deep manned submersibles.

Approach: Perform precision measurements on sound speed, temperature, salinity and pressure to study the in-situ relationships, with particular emphasis on the pressure effects on sound speed. Temperature structures and sound velocity structures near the bottom and in the top layers of sediments will be investigated. Adiabatic compressibility anomalies computed from sound speed anomalies will be correlated with other measurements, emphasis will also be given to anomalies near the sea floor, sound speed micro-structure will be analyzed by turbulence theory with application to underwater acoustic scattering and phase amplitude fluctuations affecting signal processing.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0011, PREDICITION OF SOUND FIELDS BY NORMAL MODE AND OTHER THEORY

M.A. PEDERSEN, U.S. Navy, Undersea Warfare Center, *San Diego, California* 92140

Objective: To predict propagation loss for a variety of oceanographic conditions in which the water medium itself, rather than the medium boundaries, is the controlling factor.

Approach: Modern high-speed electronic computers are used extensively and several basic theories of wave propagation in non- simple media are applied in the computer programs.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0012, UNDERWATER ACOUSTIC SIGNAL COHERENCE

G.O. PICKENS, U.S. Navy, Undersea Warfare Center, *San Diego, California* 92140

Objective: To conduct acoustic propagation and coherence studies.

Approach: Propagation is carefully analyzed for ray theory multipath conditions and for dominant propagation modes. Experiments are emphasized and are designed to determine the reliability of existing acoustic models and means for improving them.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0013, AMBIENT SEA NOISE

G.M. WENZ, U.S. Navy, Undersea Warfare Center, *San Diego, California* 92140

Objective: To determine the sources, mechanism, statistical properties and other characteristics of ambient noise in the ocean as a function of temporal and spatial parameters.

Approach: Make continuous, or sustained periodic sampling, measurements at each of several sites, with as much geographic coverage as possible, supplemented by measurements using shipborne and buoy systems in more remote areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0014, MEASUREMENT OF UNDERWATER ACOUSTIC PROPAGATION

H. WESTFALL, U.S. Navy, Undersea Warfare Center, *San Diego, California* 92140

Objective: To check, verify, and determine the anomalies between predicted propagation and measurements at sea.

Approach: Measurements stress the accurate determination of sound fields at varying ranges and depths. Measure of pronounced variation in acoustic fields due to variation of a particular propagation factor are also emphasized so that computing methods can be improved and compared with data directly applicable. The general approach is one of verification of predictions leading to subsequent improvement of prediction.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0015, ENVIRONMENTAL SUPPORT OF SONAR DESIGN

R.B. WHEELER, U.S. Navy, Undersea Warfare Center, *San Diego, California* 92140

Objective: To obtain qualitative and quantitative data on acoustic propagation characteristics of various ocean areas.

Approach: Conduct world-wide research cruises utilizing surface and submerged vehicles to obtain simultaneous acoustic and oceanographic measurements in support of acoustic model development.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0016, OCEAN ACOUSTIC ENVIRONMENT

F.N. SPIESS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (N00014-67-A-0109-0009)

This work unit is part of an overall effort to increase the body of knowledge of the marine acoustic environment.

Reduction of data from at-sea experiments will represent a significant effort during the contract year. Reverberation spatial and spectral measurement analyses will continue and a study of the 'clumping' of scatterers in the deep scattering layers will be conducted. Previously obtained ambient noise data will be analyzed with emphasis on the non-Gaussian general properties of the noise.

0TXT-ZQN-520044*

Technical Objectives: Short Term. 1. Determine the changes in the sound field which occur in various seasons in one selected location near Bermuda.

Long Term. 1. Extend the propagation loss measurement program to at least two other selected areas where considerable oceanographic differences occur. (This requires equipment development). 2. Determine the need for extension of reverberation measurements and pursue this work if it appears necessary.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0017, ARCTIC PLANKTON ECOLOGY

UNKNOWN, Mcgill University, Graduate School, *Montreal - Quebec, Canada*

Certain relatively shallow under-ice water layers in the Arctic exhibit a pronounced seasonal interference to acoustic propagation.

These studies are especially relevant to the development or improvement and utilization of underwater acoustic systems. Population studies aid in the identification of water masses of differing physical properties which are in themselves important to acoustic propagation. Organisms whether macroscopic or microscopic but present in large number per unit volume are potential sources of ambient noise and acoustic scatter. All acoustic applications require clear identification of causes of acoustic aberrations as well as determination of corrective procedures.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0018, ACOUSTIC IMAGE INVESTIGATION

W.L. KONRAD, Raytheon Company, *New London, Connecticut*

Perform experimental studies in the MRL tank facility to determine acoustic image quality and characteristics independent of an image converter system. This was accomplished by forming an acoustic image of a known target with a parabolic reflection and then probing the image plane with a high resolution probe hydrophone. The amplitude and phase distribution over the image plane were determined by this technique. The results indicated that the quality of the image formed was in general agreement with the resolution capabilities of the reflector aperture.

SUPPORTED BY Raytheon Company

1.0019, ULTRASONICS

W.L. KONRAD, Raytheon Company, *New London, Connecticut*

This project investigated the finite amplitude effects in the mid frequency range (600 KHz). The effects of surface reflection, harmonic generation and difference frequency generation of finite amplitude waves were measured. The work was performed in the MRL tank facility. Additional work was performed at Seneca Lake, New York using the BQS- 13.

Results pointed out several interesting application possibilities, including surface, ship bottom identification and source level determination through measurement of harmonic ratios.

SUPPORTED BY Raytheon Company

1.0020, SOUND TRANSMISSION IN THE SEA

H.W. MARSH, Raytheon Company, *New London, Connecticut* (N00014-67-C-0241)

This work deals with sound transmission in the sea. It includes: the development of theory; design, performance and analysis of supporting experiments; performance of appropriate surveys related to underwater sound; evaluation of experimental acoustic techniques and equipments; provision of consultant services in the above and related areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0021, INTERNAL WAVE STUDIES

P.A. BARAKOS, U.S. Navy, Underwater Sound Lab. , *New London, Connecticut*

Objective: To determine those environmental factors affecting acoustical uses of the ocean. To conduct studies of the effects of internal waves on the scattering and refraction of underwater sound.

Approach: Conduct theoretical studies and related scaled model measurements of the effects of internal waves on acoustical energy by constructing a model tank with scattering and refractions results with theory. Extend studies to a stationary sinusoidal interface between two fluids and continue these studies with a dynamic interface. Develop a program for intermediate and full scale ocean studies.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0022, BIOLOGICAL OCEANOGRAPHY

A.L. BROOKS, U.S. Navy, Underwater Sound Lab. , *New London, Connecticut*

Objective: To determine those environmental factors affecting acoustical uses of the ocean. To investigate and identify organisms affecting acoustic reverberation and reflection, and ambient noise level. To study the acoustic characteristics and the spatial and temporal distribution of these organisms to develop a predictive capability of their migration habits and population density in areas of the Atlantic Ocean.

Approach: Conduct biological studies of the deep scattering layer in the North Atlantic. Using DRV's, these studies are to consist of selective sampling via a biological sampler. Simultaneous acoustic backscattering studies will be made with available research instrumentation.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0023, AMBIENT NOISE RESEARCH STUDIES

B. CRON, U.S. Navy, Underwater Sound Lab. , *New London, Connecticut*

Objective: Study the spectral, temporal, and spatial distribution of ambient noise. Develop suitable theoretical models and conduct necessary experiments to relate ambient noise to oceanographic, geometric and acoustic parameters.

Approach: Develop theory describing surface noise and its relationship to oceanographic parameters.

Continue experimental studies of ambient noise as a function of area to develop a general non-area dependent model for ambient noise.

Conduct measurements study first and second order noise characteristics in the deep ocean as a function of depth from near surface to below the deep sound channel.

Study transient and spectral characteristics of biological noise.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0024, SIGNAL COHERENCE AND ARRAY DESIGN STUDIES

B. CRON, U.S. Navy, Underwater Sound Lab. , *New London, Connecticut*

Objective: Study the temporal and spatial characteristics of underwater acoustic signals (time and space coherence and signal distortion) and relate these parameters to array gain and design and to expected and measured performance of various methods of signal processing.

Approach: Oceanographic studies are conducted in support of acoustic measurements to physically describe reflecting boundaries. Theoretical studies are undertaken to define distortion or change in waveform and develop criteria to evaluate the experimental results.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0025, BOTTOM-REFLECTED SONAR STUDIES

J. GEARY, U.S. Navy, Underwater Sound Lab. , *New London, Connecticut*

1. PROPERTIES OF WATER

Objective: To determine quantitatively and qualitatively the effects of surface, bottom, and volume backscattering on the propagation of acoustic energy in the ocean.

Approach: Conduct a series of acoustic measurements at sea, including system calibration tests, under a variety of environmental conditions.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0026, PHYSICAL OCEANOGRAPHY

L.C. HUFF, U.S. Navy, Underwater Sound Lab. , *New London, Connecticut*

Objective: To determine those environmental factors affecting acoustical uses of the ocean. Observe and develop theory models for predicting underwater sound propagation using deep ocean water paths; Predict the effects of variability in properties of the sea surface, air and sea temperature structure related to acoustic propagation.

Approach: Using sea surface and environmental measuring systems installed on surface ships and Argus Island, make short and long term measurements of wave height and direction, wind velocity and turbulence, air and sea temperature structure in areas where acoustic studies are being conducted and integrate these measurements with acoustic programs. Relate all measurements to sound velocity and acoustic propagation and explore computer techniques.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0027, REVERBERATION RESEARCH STUDIES

R.L. MARTIN, U.S. Navy, Underwater Sound Lab. , *New London, Connecticut*

Objective: Describe the spectral, temporal, and spatial distribution and coherence of reverberation as a function of frequency, transmitted signal characteristics and the environment, including both the oceanographic and geometric situation.

Approach: Conduct theoretical and at-sea experimental studies utilizing a variety of surface and deep research vehicles.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0028, ACOUSTIC SCATTERING STUDIES

S. SANTANIELLO, U.S. Navy, Underwater Sound Lab. , *New London, Connecticut*

Objective: Investigate scattering loss of acoustic signals upon reflection from the ocean boundaries as a function of frequency, grazing angle, signal characteristics and boundary characteristics and relate these results to prediction models.

Approach: Collect, process and analyze bottom and surface acoustic reflection data obtained from various geographic areas. Oceanographic measurements are conducted in support of acoustic measurements to physically describe the reflecting boundaries such that reflection loss may be related to boundary makeup.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0029, UNDERWATER SOUND PROPAGATION STUDIES

W. THORP, U.S. Navy, Underwater Sound Lab. , *New London, Connecticut*

Objective: To study and report on underwater sound propagation in shallow and deep water as a function of frequency, environmental conditions and mode of propagation.

Approach: Determine the causes of propagation loss and attempt to resolve differences reported by various investigators. Increase the precision of knowledge concerning the attenuation coefficient. Investigate the temporal stability of shallow water propagation for improving correlation of shallow water propagation with environmental factors.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0030, SHALLOW WATER OCEANOGRAPHY

R.G. WILLIAMS, U.S. Navy, Underwater Sound Lab. , *New London, Connecticut*

Objective: To determine those environmental factors affecting acoustical uses of the ocean. To investigate the oceanographic and meteorological properties of shallow water and continental shelf areas and the effects of these environmental parameters on underwater sound.

Approach: The Block Island Fishers Island oceanographic system will be installed between Block Island and Fishers Island. Oceanographic data will be obtained and related to acoustic shallow water propagation data obtained at the same time. This will be a continuing program (2-year period) such that long and short term relationships - acoustic oceanographic - may be obtained.

Additional buoy emplantments and ships surveys are to be made on the seaward side of Block Island southeastward toward the cyclonic shear region of the Gulf Stream system. This extension will provide information on the hydrodynamic forcing functions affecting Block Island Sound as well as internal waves and turbulence of the Continental Shelf.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0031, PHYSICAL ACOUSTICS AND THE PROPERTIES OF MATTER

M. GREENSPAN, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

Study of properties of matter by physical-acoustic techniques. (1) Acoustic cavitation. What variables are decisive and how those of nuclei interact with those intrinsic to liquid? What are natural nuclei and how are they stabilized? (2) Obtain accurate values for speed of sound in water as function of temperature and produce standard for calibration of velocimeters. (3) Possible anomalies in thermodynamic behavior of single crystal ice at low temperatures. Obtain most needed data, i.e. complete set of elastic constants. Relevance: properties of well-characterized substances and production of calibration standards.

(1) Remove naturally occuring nuclei, which are variable, and substitute reproducible ones using ionizing radiation. Devise techniques for absolute measurement of sound at 'threshold' and study as function of nucleus (neutron-recoil, alpha-recoil, fission) and liquid properties and temperature. (2) Develop instrument based on radiation theory; operating principle as different as possible from existing types. Similar to conventional interferometer, but with progressive waves (simulated by long pulse) and with small baffled transducers for which far-field paraxial theory applies. (3) Elastic constants by refined pulse technique, modified for ice; L-waves and polarized S-waves, ice point to He temperatures.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1.0032, RELIABLE ACOUSTIC PATH

C.L. BUCHANAN, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

Technical Objectives: Short Term. 1. Determine the changes in the sound field which occur in various seasons in one selected location near Bermuda. 2. Determine the characteristics of the 'Deep Focus' region in a selected location near Bermuda at the first and second zones during 'winter' conditions.

Long Term. 1. Extend the propagation loss measurement program to at least two other selected areas where considerable oceanographic differences occur. (This requires equipment development). 2. Extend the study of the deep focusing region to different areas. 3. Determine the need for extension of reverberation measurements and pursue this work if it appears necessary.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0033, PREDICTIVE OCEAN ACOUSTICS

J. CYBULSKI, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

Technical Objectives: The objective is to process and report all experimental data on mean horizontal speed of sound obtained in various ocean areas.

Approach: Determine by means of a theoretical and experimental program the effects of realistic variations in velocity profile, and other oceanographic parameters upon underwater acoustics, using values representative of ocean areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0034, PREDICTIVE OCEAN ACOUSTICS

J. CYBULSKI, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

Objective: Develop techniques for predicting acoustic characteristics of ocean areas.

Approach: Conduct experiments to provide acoustic propagation data under known environmental and geometric conditions.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0035, SHALLOW WATER PROPAGATION

J. CYBULSKI, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

The objective is to increase the understanding and interrelation of acoustic and oceanographic parameters in shallow water propagation.

Approach: Undertake a program directed at understanding the fundamentals of shallow water propagation for the purpose of relating reverberation signal level and coherence to the environment, and to develop a mathematical model which will represent shallow water propagation.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0036, ULTRASONICS

V.A. DELGROSSO, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

Objective: 1. To describe acoustic propagation within liquid cylinders with realistic boundary conditions. 2. To continue development of acoustic relaxation theory for pressure sensitive chemically active media such as sea water. 3. To prepare definitive tables of sound speed and absorption for pertinent physical and chemical parameters.

Approaches: Formulate more definitive theory of laboratory acoustic propagation parameter measurements. Design and construct advanced acoustic cells as guided by newly developed theory. Improve all ancillary equipment to degree justified by theoretical predictions. Evaluate different techniques and schemes of measurement. Obtain experimental confirmation of theoretical behavior including aberrations. Prepare definitive tables of sound speed and absorption from measurements.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0037, GLOBAL VOLUME REVERBERATION LIMITATION STUDIES

G.B. FARQUHAR, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objective: Establish global environmental time-space models and methods for delineating biological reverberation provinces, by relating distributions and types of biological sound scatterers to observed volume reverberation. Special emphasis is placed on providing models and techniques for improving existing prediction methods.

Approach: Conduct coincident acoustic and biological measurements to determine relationships between biological scattering and the distribution of midwater scatterers. Collected biological samples will be used to identify and determine the distribution of scatterers, and for swimbladder physiology studies. Detailed experiments will be conducted in the North Atlantic using newly developed airborne and shipboard techniques to determine seasonal, diurnal, depth and geographic variations of volume reverberation.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0038, UNDERWATER ACOUSTIC ANALYSIS

R.H. FERRIS, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

The objectives are to: l. Predict effect of oceanographic parameters on the characteristic of the acoustic signal, and 2. Develop requirements for signal design and signal processing to improve propagation.

Approaches: Conduct an extensive search, study, and analysis of all published results and conduct a thorough theoretical and experimental program to determine the relationship of signal characteristics to the ocean environment.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0039, ENVIRONMENTAL REVERBERATION STUDIES

A.J. HILLER, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

Objective: To determine those environmental factors affecting acoustical uses of the ocean. To study the relation between particulate and microbubble distribution in the sea and acoustic volume scattering strengths in order to better understand the nature and cause of volume reverberation.

Approach: Obtain particle, bubble, optical and acoustic profiles at sea utilizing an in-situ particle analyzer and an in-situ microbubble analyzer. Relate data obtained to scattering theory and temperature, salinity and sound velocity. Analyze PARTICULATES using an electron microscope. Using a tank, conduct experiments to determine scattering strength and absorption of water containing known particulates and controlled microbubbles.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0040, SOUND SCATTERING IN THE OCEAN

B.G. HURDLE, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

Objective: Describe in mathematical terms the scattering of acoustic energy from the ocean bottom, volume and surface.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0041, BIOLOGICAL FALSE TARGETS AND RELATED ACOUSTIC CHARACTERISTICS

R.H. LOVE, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

OBJECTIVE: In conjunction with the Department of the Interior, develop techniques for improving biological false target and fish detection, classification and prediction methods, and techniques of applying such predictions on a global basis in conjunction with Navy environmental prediction systems. In accordance with the Memorandum of Agreement between the Department of the Navy and the Department of the Interior, primary emphasis is placed on cooperation with the Department of the Interior and utilization of joint Navy-Interior capabilities in support of national goals.

APPROACH: In collaboration with the Department of the Interior, conduct investigations to determine the acoustic properties of marine organisms in order to identify potential biological false targets. Experiments will be conducted to determine target strengths and echo signatures of individual organisms and fish schools. Joint experiments will be conducted with the Bureau of Commercial Fisheries to detect, localize and classify marine organisms.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0042, SHALLOW WATER ACOUSTIC STUDIES

A.T. MCCLINTON, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

Objective: To provide fundamental information necessary to develop accurate acoustic prediction models for use in shallow water areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0043, MICROACOUSTICS

W.G. NEUBAUER, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

Objective: l. Increase the knowledge of the mechanisms of acoustic reflection and diffraction. 2. To develop the capability of experimental determination of reflection from bodies not possible by analytical means. 3. Establish realistic scaled thermal gradients in a water tank to determine their effect on echo characteristics.

Approach: The reflection in water from less complicated bodies, (spheres, cylinders, spheriods) have been experimentally measured by several investigators seldom very extensively or in correspondence with a reliable theory. A group at DRL at the University of Texas have measured such reflection in a lake. Qualitative agreement with theory is available for some cases and quantitative agreement is within a factor of two or three in the best cases. Acoustic reflected and scattered fields must be measured with much more precision than heretofore and a correspondence with complete theory must be achieved for a limited number of specific cases sufficient to establish an experimental method with confidence.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0044, ACOUSTIC PROPAGATION STUDIES

L.C. RICALZONE, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

Objective: Develop theory, design and develop oceanographic instrumentation, and conduct field experiments in support of acoustic propagation studies.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0045, ADVANCED TECHNOLOGY AND BOTTOM PREDICTIONS

R.S. WINOKUR, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objective: Develop new and improve existing bottom acoustic data collection and analysis methods for improving NAVOCEANO's survey programs. Develop global bottom acoustic models and techniques for predicting the behavior of bottom influenced sound propagation to improve existing prediction methods for use by NAVOCEANO operational programs.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0046, CIRCULATION STUDIES

S. BROIDA, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124 (NONR)

Objective: This effort is to improve our ability to predict environmental conditions influencing the operations of naval forces and the effective use of systems and equipment, especially those conditions affecting underwater sound.

Approach: Changes in the oceanographic conditions observed across the Florida Current are being correlated with simultaneously observed variations in acoustic transmissions across the current. The amplitude and phase fluctuations observed in low frequency (420 Hertz) acoustic signals transmitted across the Straits of Florida are being related to time series of temperature, salinity and current velocity obtained along the transmission path. The influence of tides upon the current velocity structure and acoustic propagation conditions is being investigated. A two-week series of continuous oceanographic observations will be made to correlate tides and variations in the water masses of the Florida Current.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0047, BEHAVIOR AND SONIC ACTIVITY OF FISHES

A. MYRBERG, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124 (N00014-67-A-0201-0004)

Objective: The identification and prediction of the animal forms involved in the problem of biologically generated underwater sound is assuming increased importance. The design of this work unit, centering on the use of the unique Bimini Acoustic-Video System, is permitting direct and unequivocal observation of sound producers during a variety of activity patterns.

Approach: Utilizing the capability of the Acoustic-Video System located at the Lerner Marine Laboratory, Bimini, Bahamas, a correlation of the behavior and bioacoustic activity of the bicolored damselfish, Eupomacentrus partitus, will be made with the operant environmental factors. Taped video and acoustic recordings of behavior will be analyzed and physical data on turbidity, light level, current speed and direction, and temperature will be integrated to reveal causal relationships. Acoustic playback experiments, using sounds of this and other sonic fishes will be completed, both in the field and in controlled laboratory conditions, as to behavioral reactions of the fish to the sound patterns.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0048, AMBIENT SEA NOISE INVESTIGATION

J.C. STEINBERG, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

Objective: To determine thos eenvironmental factors affecting undersea uses of the ocean. Make time series measurements of ambinent noise level related to concurrent wind/wave measurements.

Approach: Using an IBM 7040-1401 computer and applying time series techniques and standard statistical treatments to data obtained off Bimini, Bahamas during the period 10 Sept 66 to May 67, determine relationships between ambient noise levels and environmental parameters to develop a math model in which a frequency dependent linear system of multiple inputs consisting of environmental parameters may be expected to determine a single output which would be ambient noise. Very narrow band noise measurements will be obtained. Real time analyses of the amplitude and phase characteristics of this narrow band noise will be performed. The distribution of pressure fluctuations of 1/3 octave band noise at selected frequencies during different environmental, bio-acoustical and shipping conditions will also be determined. LINC-8 data processors will be used for the high speed analogue-digital sampling and computation of this data.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0049, ACOUSTIC-VIDEO SYSTEM FOR AQUATIC BIOACOUSTICAL AND ETHOLOGICAL RESEARCH

J.C. STEINBERG, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124 (NONR)

Objective: The exigencies of Naval marine technology require that more detailed information be made available on biologically produced underwater sound. The Acoustic-Video System designed by Dr. Steinberg is providing direct and unequivocal observation and recording of sound producers in their natural environment.

Approach: The investigator and his staff will continue to operate, maintain, and modify, as requested by the biologists, the Acoustic Video System located in 20 meters of water off the NW Coast of Bimini in the Bahamas. This array will be used to permit bioacoustic behavioral studies on sonic animals in the field. Dr. Steinberg's team will continue to work closely with the biologists and expand the interdisciplinary approach to marine bioacoustical problems.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0050, SHALLOW-WATER ACOUSTICS

M. WEINSTEIN, Underwater Systems Inc. , *Silver Spring - Wheaton, Maryland* 20910 (N00014-67-C-0480)

Review all literature pertinent to shallow-water acoustic transmission. Extract, collate, summarize, and annotate theoretical and experimental data. Visit facilities engaged in shallow-water acoustic studies to obtain unpublished information. Collate new material with original summary acoustic data (SAD) Report (1956) and issue revised and updated publication.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0051, SONAR ACCURACY

A.T. JAQUES, U.S. Navy, Ordnance Laboratory, *Silver Spring - White Oak, Maryland*

To determine sonar bearing and ranging errors at long ranges.

Make acoustic propagation measurements with a stable research platform (SPAR).

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0052, OCEANOGRAPHIC RESEARCH
UNKNOWN, U.S. Navy, Ordnance Laboratory, *Silver Spring - White Oak, Maryland*

To study the effect of ocean dynamics on the behavior of submerged moored bodies. To investigate the effect of shallow water and coast proximity on acoustic transmission properties. To develop the necessary instrumentation to carry out the above studies.

Measure the current and the motion of a submerged body at selected locations. Determine how the two phenomena are related. Measure acoustic signals at selected coastal sites. Determine how the original signal is modified and identify the oceanographic parameters which contributed to the modification.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0053, ACOUSTIC AMBIENT NOISE
M. ARSOVE, Raytheon Company, *Waltham, Massachusetts*

Design, construction and operation of instrumentation to collect data relevant to determining the characteristic power spectra, amplitude distributions, directional properties, and relationship to ambient noise at depth of the near-surface acoustic ambient noise.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0054, BIOLOGICAL ASPECTS OF MIDWATER SOUND SCATTERING
R.H. BACKUS, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

The long term goal is to understand the geographic distribution of mesopelagic fishes in the North Atlantic Ocean and adjacent seas. The investigations will include charting of the distribution of mesopelagic fishes by species in order to show principal distribution patterns, and to point to physical bases for the apparent patterns. Midwater trawl collections are to be accompanied with sound scattering observations in efforts to correlate echo soundings with possible causative organisms. With the development of adequate gear, attempts will be made to determine the relation of patterns of sound scattering to vertical distribution of mesopelagic fishes. Such collections would be accompanied by continuous echo soundings and by broad-band sound scattering observations. Refinement of such gear as midwater sampler, pneuston nets, and echo sounders are to be continued. Further observations are to be made on microbioluminescence both in the sea and in Eel Pond at Woods Hole in order to understand something of the seasonal fluctuations in bioluminescence. Underway observations at sea will be made for studying geographic variations in such activity. Finally, dives are to be made in a deep-going submarine for the purpose of making direct observations of sound scatterers in deep scattering layers using echo-ranging and sounding gear.

SUPPORTED BY U.S. National Science Foundation

1.0055, EASTERN ATLANTIC AND MEDITERRANEAN OCEANOGRAPHY
E.E. HAYS, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

The purpose of this task is to support Woods Hole research scientists to participate with the UK scientists in a cooperative study of underwater sound experiments in the Eastern Atlantic and the Mediterranean Sea. Bathymetric and sound velocity and noise measurements will be included. The task will also provide for analysis and interpretation of data.

This is part of a coordinated program to determine the oceanographic and acoustic structure of the Mediterranean. The WHOI scientists aboard the R/V CHAIN will participate in a joint cruise with a UK vessel.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0056, WOODS HOLE ENVIRONMENTAL STUDIES IN PHYSICAL OCEANOGRAPHY
E.E. HAYS, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (NONR)

Objective: Improved understanding of the oceanographic factors that affect acoustic systems (both current operations and for future designs. To relate the properties of the oceanic environment to specific modes of acoustic transmission.

Approach: Obtain sound velocity profiles in terms directly related to specific acoustic experiments, and as a general oceanographic tool. Develop an on-line sound velocity profiling system using the shipboard computer. Use a STD (Salinity-Temperature-Depth) system to study oceanic fronts and gain information on the possible structure and movement of the water.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0057, WOODS HOLE ENVIRONMENTAL STUDIES OCEANIC ACOUSTICS
E.E. HAYS, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (NONR)

OBJECTIVE: Improved understanding of sound transmission and scattering in the ocean with a view toward providing equipment designers a description of opportunities and limitations they can use to define the environmental component of their systems.

APPROACH: Complete analysis of sound transmission path data obtained in the Baltic in FY 1967 to determine the extent that it can serve as a model for the deep oceans. Conduct transmission experiments in the Northwest Atlantic, over ridges and down slopes to show bottom effects. Make field measurements of volume reverberation, identify sources of sound scatterers and identify the mechanisms which cause volume reverberation. Include in these measurements the interaction effects caused by fish swim bladders and fish schooling habits.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0058, ACOUSTICS PHYSICS
W. HARDY, Hudson Laboratories Inc. , *Dobbs Ferry, New York* (NONR)

Conduct studies of underwater acoustic transmission to provide the Navy with scientific and technical knowledge of underwater sound and related disciplines.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0059, THE PROPAGATION OF ACOUSTIC WAVES IN THE STRATIFID ATMOSPHERES
W.L. DONN, Columbia University, Graduate School, *New York, New York* 10027

Technical Objective: Propagation parameters of pressure perturbation, vertical and horizontal motion, and kinetic energy along the vertical have been developed for gravity and acoustic gravity waves of long period (of the order of minutes). This study will be extended to pure acoustic waves of much shorter period (1 to 10 seconds).

Approach: The program consists of two aspects- (1) Theoretical analysis of acoustic wave propagation involving the application of the wave equations to the real atmosphere considered as being stratified in terms of both temperature and wind. (2) An experimental analysis of spectral characteristics of acoustic waves recorded by microphones.

SUPPORTED BY U.S. Dept. of Defense - Army

1.0060, BIOLOGIC SOUND SCATTERING
A.W. BE, Columbia University, Graduate School, *Palisades, New York* 10964 (N00014-67-A0108-0004)

This program is directed at measuring total volume reverberation levels in the ocean and correlating them with the plankton-nekton standing crop. The newly initiated and specialized biological sampling program will be continued along with the concurrent acoustic measurements under controlled conditions using broad band and discrete sound sources. Correlation of biomass data and PDR records from past cruises will continue.

Volume reverberation is thought to result in part from sound scattering by biological organisms and varies in intensity with depth, geographic locality, time of day, time of year, and sound frequency. The information on such variations and their interrelationships which will be provided by this program, should considerably improve the Navy's ability to predict acoustic conditions as a function of time of day, time of year, and geographic location.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0061, OCEAN SOUND TRANSMISSION
EWING, Columbia University, Graduate School, *Palisades, New York* 10964 (NONR)

A broad program of applied research is conducted on sound transmission in the ocean, and on phenomena controlling it.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0062, RESEARCH IN OCEANOGRAPHIC SPECIAL CHARTS
W.M. EWING, Columbia University, Graduate School, *Palisades, New York* 10964

Objective: To determine those environmental factors affecting acoustical uses of the ocean. To investigate and characterize the properties of the ocean bottom and sub-bottom including acoustic properties and to delineate physiographic provinces of the ocean bottom.

Approach: Extrapolate and interpolate the oceanographic and acoustic properties of known to unknown bottom areas and categorize areas into similar acoustical provinces. Observe and develop theory and models for predicting underwater sound propagation using deep ocean water paths including near bottom phenomena. Delineate and chart oceanic provinces on the basis of topography, sediment type, roughness, etc. and the accompanying acoustic properties of the bottom and the sub-bottom. Refine these charts on the basis of reflectivity measurements and bottom and sub-bottom profile records.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0063, RESEARCH IN REGIONAL TOPOGRAPHIC ANALYSIS
W.M. EWING, Columbia University, Graduate School, *Palisades, New York* 10964

Objective: To determine those environmental factors affecting uses of the ocean. Extrapolate and interpolate the oceanographic properties of known to unknown bottom areas and categorize strategic areas into similar provinces.

Approach: Study the statistical properties of the bottom topography including both slope and roughness and relate these properties to the physiographic province in the oceans. Develop suitable data presentation methods and analyses.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0064, BIOLOGICAL SOUND
M.P. FISH, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881 (NONR)

The investigator, who has frequently been asked by the Navy to provide identifications, measurements, and analysis of biological sources of underwater sound along United States coasts and territorial waters, has established a series of stations at faunally strategic points making possible the collection of continual, integrated simultaneous information on seasonal, diurnal, and vertical distribution of biological ambient sounds and the occurrence, distribution, and significance of these sounds. Monitoring-recording equipment has been supplied to each station for use under the cognizance of a senior scientist. The planned study area covers the geographical range of the most noisy contributors to the general background.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0065, SHALLOW WATER ACOUSTIC PROPAGATION STUDIES (SWAPS)
K.T. CROCKER, U.S. Navy, Underwater Weap. Res. & Eng. , *Newport, Rhode Island* 02844

Technical Objective: Investigate some of the characteristics of sound propagation in shallow water and to relate these observations to the oceanographic environment.

Approach: Investigation will be conducted on the fluctuations of the level and relative phase of an acoustic signal propagated over a fixed range in shallow water and the regulation of the fluctuations to such oceanographic parameters as tide height, sound speed distribution, thermal microstructure, turbulent motion, and sea state. Upon selection of suitable sites, a detailed study of the bottom topography, the subbottom layering, and their acoustic properties will be undertaken. An indication of the acoustice field expected will be obtained from the geometry of the range, the properties of the bottom, and representative velocity profiles, using ray or normal mode techniques.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0066, EFFECTS OF THERMAL MICROSTRUCTURE ON ACOUSTIC TELEMETRY
D. BUGNOLO, Raytheon Company, *Portsmouth, Rhode Island*

Acoustic telemetry channels in the ocean environment will be affected by the relative motion of source and receiver and by the stochastic character of the medium. This study considers the effect of thermal microstructure on the phase and amplitude of an acoustic signal transmitted over the surface to bottom path, as in the case of a surface vessel to bottom mounted buoy. The phase and amplitude variations are related to the spectrum of the sound velocity variations. These are in turn related to the thermal microstructure and currents in the medium. Examples are evaluated using a Kolmogoroff spectrum for the temperature variations, based on physical constraints. Further experimental effort including simultaneous oceanographic and acoustic measurements is required to verify the theoretical predictions.

SUPPORTED BY Raytheon Company

1.0067, BI-STATIC ECHO RANGING
E.L. DANIELS, Raytheon Company, *Portsmouth, Rhode Island*

Objective: To improve bi-static ranging techniques.

Approach: Collect bi-static echo ranging and reverberation data at sea in various propagation modes over a wide range of geometries.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0068, DEVELOPMENT OF ANALYSIS TECHNIQUES FOR CLASSIFYING TRANSIENT HYDROACOUSTIC SIGNALS
R. PLUTCHOK, Teledyne Incorporated, *Garland, Texas*

One part of a continuing effort to develop an operational system for classifying transient hydroacoustic signals was a study to define analytical methods for signal identification. To this end, signal analysis procedures were developed which were based both on in-house research and on the findings of other investigators in this and in related fields.

These investigations were conducted by Earth Sciences, A Teledyne Company, at 314 Montgomery Street, Alexandria, Virginia.

SUPPORTED BY No Formal Support Reported

1.0069, ACOUSTIC SCATTERING
R.S. HAYRE, Univ. of Houston, Graduate School, *Houston, Texas* 77004 (NONR)

This task deals with the development and evaluation of models for scattering at the ocean surface and in its volume taking account of the effects of waves and entrained bubbles. Both analytic studies and model experiments in a tank will be performed and the results of these studies will be compared with sea data obtained by the University of Miami. It also includes the analysis of reflectivity data.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0070, DEVELOPMENT OF ANALYSIS TECHNIQUES AND EQUIPMENT FOR CLASSIFICATION OF TRANSIENT HYDROACOUSTIC SIGNALS
J.N. GRIFFIN, Teledyne Incorporated, *Alexandria, Virginia*

This project was undertaken to assemble an on-line hydroacoustic signal processing system implementing the findings of earlier research in methods for classifying transient signals, and to continue the development of robust methods for signal classification and identification.

SUPPORTED BY No Formal Support Reported

1.0071, HONEYWELL ACOUSTIC RESEARCH PROGRAM

P. MOOSE, Honeywell Incorporated, *Seattle, Washington*

The Honeywell Acoustic Research Program is an applied research project on the physics of acoustic reverberation in the sea. Reverberation, or clutter as it is called in radar, is a noise-like signal present to some degree in all active sonar sets. It is the superposition of many small echoes reflected or scattered from inhomogenities in the medium and from the boundaries; but it excludes signal returns which have interacted with the target. (Those signals excluded are called the direct echo and attendant multi-path structure of the target.)

In order to accomplish target detection, estimation and/or classification problems with sonar, we need to establish certain statistical parameters of the reverberating structure. The first phase of the Honeywell Acoustic Research Program concentrated on theoretical models and formulations and upon preparation of special purpose instrumentation. The second phase, which is in progress, is to gather and process large amounts of data required in furthering this research.

Reverberation measurements will play an increasingly important role in oceanography and will help advance the state-of-the-art in marine physics and sonar.

SUPPORTED BY Honeywell Incorporated

1B. CHEMICAL PROPERTIES

1.0072, CHEMICAL OCEANOGRAPHY

D.W. HOOD, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

Arctic water masses will be characterized by detailed analyses of inorganic and organic components. These, with selected organic and trace metal analyses, and determination of ionic gradients beneath sea ice, will provide basic data for the understanding of water movement and mixing, and provide insight into biogeochemical processes. Certain organic compounds will be used as specific tracers to provide quantitative data on water source and time-averaged currents. Large samples of dissolved organic material uniquely obtainable due to the slow drift of T-3 will be dated by 14C and time-averaged currents will be calculated from knowledge of the age distribution of the tracer. Terrestrial and marine sources of water will be determined by study of 13C/12C rating of organic matter. Emphasis will be placed upon processes and mechanisms of cycling of organic carbon.

These studies contribute to basic knowledge of chemistry of marine waters. The physico-chemical structure of sea water has an important bearing upon all of man's uses of the sea. Processes of basic reactions and chemical cycling of the sea, especially organic carbon cycling, are of greatest relevance and the understanding of these for each of the layered water masses provide relevant data on the dynamic processes of water movement and mixing and the interchange of mass and energy with the other oceans.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0073, MARINE INTERFACE CHEMISTRY

D.W. HOOD, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735 (NONR)

The objectives of this task are to understand the processes responsible for observed concentrations and gradients at the air-sea interface, and to determine if detectable gradients exist at other marine interfaces such as fresh-salt water, and between different water masses. The sampling at the air-sea interface will be accomplished using a screen, and the gradients in the first meter by use of a special float-supported tube with intakes at closely spaced intervals. Chemical measurements will include plant nutrients, dissolved and particulate organic matter, lipids and a number of inorganic ions.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0074, GEOCHEMISTRY OF SAN FRANCISCO BAY

J.R. KRAMER, U.S. Dept. of Interior, Water Resources Division, *Menlo Park, California*

Purpose: To determine abundance, distribution, and clay mineralogy of suspended sediments in San Francisco Bay and their influence on the overall quality of bay waters.

Methods: Study of the composition of selected geochemical constituents with depth in sediment in relation to source. Plot distribution and occurrence of trace minerals in bay sediment and waters.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

1.0075, ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS

D.H. PETERSON, U.S. Dept. of Interior, Water Resources Division, *Menlo Park, California*

Purpose: To increase our limited knowledge of the factors which control the abundance, distribution, and composition of organic matter in coastal waters and sediment.

Methods: 1) Determine the relative abundance, distribution and clay mineralogy of suspended sediment in San Francisco Bay waters in relation to source and waters, such as the distribution of saline water. 2) Survey the abundance and distribution of organic carbon in San Francisco Bay waters and sediment in relation to season, source and differences in depositional environment such as the distribution of NO3 and oxygen dissolved in the waters. 3) Study the distribution of specific trace elements in relation to the distribution of organic matter. 4) Survey the distribution of pesticides in sediment in relation to depositional environment and depth in sediment. 5) Study abundance and composition of organic matter thought to be of prime importance in the engineering properties of sediment. 6) Study the composition of selected geochemical constituents with depth in sediment in relation to source and subsequent alteration of organic matter.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

1.0076, SEA WATER CHEMISTRY

T.J. CHOW, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038 (NONR)

Techniques for separating and identifying trace materials in sea water, snow, and atmospheric aerosols will be developed and applied to the determination of the distribution of rare earths, indium, molybdenum, potassium, and calcium. Mass spectrometry will be applied to the detection of small amounts of lead and to determination of isotope ratios for identification of the origins of these lead traces.

Knowledge of the natural and industrial background values for concentration of lead in sea and atmosphere is important in establishing levels above which possible higher concentrations may exist. The present main sources of industrial lead are probably insecticides and motor exhausts.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0077, LIGHT ISOTOPE STUDIES

H. CRAIG, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038 (NONR)

A study of fractionation of hydrogen isotopes (deuterium) and oxygen isotopes in sea waters, sea ice, and atmospheric precipitation will continue and will be interpreted in terms of mixing rates and kinetics of evaporation and gas exchange at interfaces. The recent discovery that the oxygen in sulfate and in sea water exchanges very slowly with oxygen in water molecules will be exploited as a means of investigating past oceanic temperatures, residence times of sulfate in the sea, and the kinetics of the sulfate-sulfide reactions in sediments and stagnant basins.

1. PROPERTIES OF WATER

The slow and complex nature of mixing processes in the deep ocean makes it mandatory that all possible parameters be investigated for their contribution to the overall understanding of oceanic circulation. The study of isotopic variations provides an important addition to the chemical and physical methods of examining large-scale ocean mixing processes.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0078, EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS

F.H. FISHER, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The physical chemistry of electrolytes such as magnesium sulfate and its effect on the conductivity and acoustical properties of sea water has been the subject of recent dispute. Minute amounts of salts such as magnesium sulfate in sea water produce a sound absorption of thirty times that exhibited in fresh water. Not only is this of fundamental interest to the physical chemist concerned with reaction kinetics but it is of primary concern to the oceanographer who must interpret conductivity versus pressure data. The problem of the complex relationship between conductivity, temperature, pressure and specific salt content of sea water has been intensified by the introduction of conductivity meters to determine 'salinity' which in turn is converted by an arbitrary relationship to density.

The principal Investigator will make precise measurements on the electrical conductivity of sulfate aqueous solutions as a function of temperature and pressure using data on dielectric constants, viscosity and density. The addition of pressure to the systems should give more realistic values on the shifts in conductivity and acoustic properties of sea water.

SUPPORTED BY U.S. National Science Foundation

1.0079, EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS

F.H. FISHER, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

Plans are for continuation of the study of the effect of pressure on conductivity of electrolyte solutions, in particular 2-2 sulfates, started under NSF Grant GP-4748. The 2-2 sulfate electrolytes exhibit unusual acoustic absorption properties which have been investigated at atmospheric pressure by ultrasonic relaxation spectroscopy techniques. Wide variations in acoustic properties related specifically to the cation have been discovered which contrast with the great similarities in such properties as activity coefficients and equilibrium constants. The physical chemistry of these salts is difficult and a subject of dispute. Recent work has led to the concept of a four-state dissociation model which is used to account quantitatively for the unusual acoustic absorption in these solutions in terms of simultaneous pressure-dependent chemical reactions.

SUPPORTED BY U.S. National Science Foundation

1.0080, STUDY OF THE DISTRIBUTION OF RADIONUCLIDES IN THE OCEAN DETAILED EXPLORATION OF CS137 IN THE OCEAN

T.R. FOLSOM, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (AT(11-1)34,PROJECT071)

1967 Objective: Collecting detailed distribution of fallout especially in upper layers of the N. Pacific to indicate mixing and circulation rates and the behavior of elemental cesium in the ocean.

Background: Several years work has culminated in a successful means for rapidly surveying Cs137 in the ocean by concentrating in situ on absorbers at any depth.

Procedure: Cartridges of ferrocyanide granules are exposed at sea, then analyzed for Cs137 and Cs133. Environmental cesium is monitored and used to give the yield.

Results: Pacific surface Cs137 concentrations vary with latitude similar to predictions from soils; they vary longitudinally consistent with reported ocean circulation, indicating very slow downward mixing. Several surface minima suggest upwelling in mid-ocean, also persistent high concentrations in thin laiminae below the mixed layer suggest a mixing is so slow as to be described by a mixing constant of the order of 0.001 cm.2/sec.

1967 Proposal: 1. Intercepting a concentration front believed advancing south of Hawaii to further determine transport and diffusion rates. 2. Detailed cesium section of 'N. Pacific Current' near 170 degrees W to confirm suspected upwelling. 3. More detailed subsurface measurements near 30 degree N, 150 degrees E and 30 degrees N, 140 degrees W to estimate the advance of intermediate waters southward. 4. Detailed reinspection of Cs133 anomalies discovered near Samoan and California shores. 5. Further refinements in Cs133 and Cs137 collecting and analytical techniques. 6. Summarizing Cs137 findings to date correlated with other data in oceanographic reports.

SUPPORTED BY U.S. Atomic Energy Commission

1.0081, STUDY OF THE EXCHANGE OF CARBON DIOXIDE BETWEEN THE ATMOSPHERE AND THE OCEANS

C.D. KEELING, Univ. of California, Graduate School, *San Diego — La Jolla, California* 92038

The long-range goal of this oceanic investigation is to describe the mechanism of the exchange of CO2 between the oceans and the atmosphere. Towards attainment of this goal it is proposed to: (1) to conduct a seasonal study of horizontal and vertical variations of all of the determinative chemical species related to CO2 gas, and (2) to continue laboratory investigations of the chemistry of inorganic carbon in ocean water, and (3) to automate additional phases of data processing both at sea and in the laboratory.

SUPPORTED BY U.S. National Science Foundation

1.0082, PHYSICAL CHEMISTRY OF BUBBLES

F. MACINTYRE, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

This project, now completed, investigated certain physicochemical hydrodynamic features of breaking bubbles and also the effects of capillary ripples upon interfacial gas exchange. More detailed accounts may be found in MacIntyre, J. Phys. Chem. 72, 589 (1968) 'Bubbles: A Boundary-Layer 'Microtome' for Micron-Thick Samples of a Liquid Surface', and in MacIntyre (submitted to J. Fluid Mech.) 'Enhancement of Interfacial Gas Transfer by Capillary Ripples'.

SUPPORTED BY Amer. Chemical Society

1.0083, DETERMINATION OF TRITIUM IN NATURAL WATERS

H.E. SUESS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The proposal is a continuation of NSF Grant GA-784 and it is concerned with measurements of tritium in ocean water, in precipitation and in various types of samples representative of the pre-bomb tritium level. Tritium will be used as a tracer in oceanographic problems that include distribution in both vertical and horizontal directions. It will also be used to trace differences in rain water in different parts of the world. Correlations between pre-bomb tritium content of aqueous materials and present tritium content of similar materials will be made.

SUPPORTED BY U.S. National Science Foundation

1.0084, NATURAL RADIOCARBON MEASUREMENTS

H.E. SUESS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

This grant provides support for the continued operation of the principal investigator's radiocarbon dating laboratory. Radiocarbon determinations are being carried out in connection with the following lines of research: 1. Distribution of natural radiocarbon in bicarbonate of the deep oceans for the investigation of movement of deep ocean water masses. 2. Distribution of artificial radiocarbon in the surface water of the Pacific Ocean for the purpose of investigating mixing through the thermocline. 3. Determination of carbon-14 dates in connection with other research carried out at the Scripps Institution of Oceanography and by the Earth Sciences Department.

SUPPORTED BY U.S. National Science Foundation

1.0085, TRACE ELEMENTS IN SEA WATER

K.K. TUREKIAN, Yale University, Graduate School, *New Haven, Connecticut* 06520

During the next year we propose the following program to continue our studies of the marine geochemistries of the trace elements. It is hoped that knowledge of the behavior of the naturally occurring and pollution contributed trace elements in natural waters will also assist in the understanding of the behavior of radioactive nuclides from reactors and other potential sources of radioactive waste.

Long Island Sound studies: We will complete the neutron activation analysis for Long Island Sound water profiles for cobalt, nickel and silver. An attempt will be made to make a material balance for as many elements as possible in Long Island Sound using stream, sea water and sediment data. This is of importance not only because of the imminent construction of nuclear reactors in the state of Connecticut but also as a general model of the behavior of trace elements for analogous areas around the world.

Analytical methods: We shall continue in the development of neutron activation analytical techniques for the analysis of stream waters. With the use of sodium carbonate carrier and freeze-drying in addition to Co, Ni and Ag we expect to develop techniques for the determination of the following elements from the processing of a single 100 ml aliquot of water: Hg, Se, Sb, Cr, Rb, Cs, Au, Zr, Hf, Ta, Zn, Fe, Sc, Ba, Sr, Te, Mo.

Techniques for the accurate determination of uranium and molybdenum will be developed. Uranium will be determined by neutron activation and alpha spectrometry and molybdenum will be determined by mass spectrometric isotope dilution and possibly by neutron activation. These elements are of interest not only because of their peculiar geochemical properties but also if found to be constant in concentration in sea water as indicated by some workers, for use as monitors in the sponge adsorption experiments.

SUPPORTED BY U.S. Atomic Energy Commission

1.0086, HEAVY METAL GEOCHEMISTRY OF ANTARCTIC SEA WATER AND MARINE SEDIMENTS

K.K. TUREKIAN, Yale University, Graduate School, *New Haven, Connecticut* 06520

This award continues a study of variations in the content of heavy metallic elements in the Antarctic Ocean. Previous support was under GA-110, GA-183, and GA-275. Deepwater samples were collected on Eltanin Cruises 11 and 22. These are being analyzed chemically and radiometrically for Ag, Cu, Ni, U234, U238, and the alkaline-earth metals (Ba, Sr, and Ca). Siliceous sediments from deep-sea cores in the same areas were analyzed for Si32, C14, and the uranium-decay series. These determinations were analyzed to relate the variations of the different elements to biological activity and to the rate of mixing of the ocean water masses. It is proposed to continue the analyses of Eltanin samples and of the data. Strontium in untreated sea water will be determined by atomic absorption spectrophotometry. Results to be compared with analyses obtained by mass-spectrometic, isotopic-dilution techniques. The same water samples to be analyzed for specific alkalinity. These two sets of data will be used to understand both the oceanic circulation around the Antarctic regions, and the geochemical properties of Antarctic water. Analyses already made on isotopes of Si, C, and the uranium-decay series will be compared for a determination of the rates of sediment accumulation in Antarctic deep-sea sediment cores. These rates will be compared with the barium content of the cores and of the water for a further check on the flow rates between the Antarctic Ocean and the other major oceans.

SUPPORTED BY U.S. National Science Foundation

1.0087, PH STANDARD REFERENCE MATERIALS FOR USE IN SEA WATER

R.G. BATES, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

Technological Objectives: The hydrogen ion activity (pH) is an important parameter in chemical and biological processes. Over the years a pH scale in water has been developed at the National Bureau of Standards augmented by a series of standard reference materials. As work is extended to other systems (deuterium oxide, sea water, non- aqueous solvents), a parallel activity scale and a series of standard reference materials must be developed. The increasing interest in oceanography has made the development of a pH scale in sea water most pressing. The present work at NBS to define a pH scale in sea water and develop standard reference materials will fill the need in this area.

Approach: A 'standard' sea water for this work is being developed and a pH scale is being defined in this medium. Accompanying this is a study of the deviations in pH with changes in salinity. Once the scale is established, work will begin to prepare and standardize a group of defining standard reference materials.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1.0088, TRACE ELEMENT EQUILIBRIUM STUDIES

J.D. GASSAWAY, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objective: To investigate equilibrium distribution coefficients and uptake rates of elements and suites of elements on ion-exchange resins containing various organic complexing and precipitating agents.

Approach: The initial effort will be directed at establishing the optimum conditions for adsorbing and/or absorbing organic complexing agents onto ion exchange resins. Immediate attention will be given to dithizone, 1-nitroso-2-napthol, dimethylglyoxime, 8 hydroxyquinoline, and ammonium pyrrolidine dithiocarbamate on Dowex 1 of varying mesh sizes. Using appropriate radioactive tracers (e.g. zinc, cobalt, copper, nickel, antimony, manganese, iron, chromium and the rare earths), studies will be made of: (i) their equilibrium distribution coefficients in a sea water matrix with a pH ranging from 2 to 9 under controlled conditions: (ii) elution characteristics of the exchangers employing various eluants (both organic and inorganic); (iii) trace element recoveries from large volumes of sea water; and (iv) factors affecting recoveries.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0089, OCEAN RADIOACTIVITY

J.I. HOOVER, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

Objectives: To make measurements of the neutron intensity as a function of depth. To increase our knowledge of the neutron distribution in the ocean.

Approach: The experimental approach is to utilize currently available, highly sensitive counters to detect the neutron component in the ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0090, ISOTOPIC OCEANOGRAPHY

R.E. SMITH, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

OBJECTIVE: Develop capabilities for the measurement and utilization of radioisotopes and stable isotopes in the sea to provide NAVOCEANO survey forces the ability to rapidly and selectively collect marine radiochemical and trace element samples for use in studying oceanographic phenomena and to respond rapidly to oceanic disasters involving nuclear material. Provide the capabilities for survey measurement, prediction and search capabilities for radioisotopes at low levels and stable trace constituents at levels of 1 ppm or less.

APPROACH: Collection and radiochemical analysis of sea water, bottom sediment and plankton, samples from selected Arctic areas. The data are studied with other physical and chemical oceanographic parameters to determine the manner in which the spatial and temporal isotope distributions reflect environmental features. Chemical, geological and biological considerations are to be made of Arctic and Tropical areas to fully evaluate controlling factors on stable and non-stable isotopic distributions. The radioisotope levels observed will be used to provide background levels for reference for future measurements in the Arctic and/or other areas of interest. Results will be used as a guideline in determining the feasibility of future isotopic surveillance efforts and for modifying sample collection and laboratory analytical techniques for more efficient and rapid data procurement. Utilize injection sources, such as nuclear reactors, to study the properties of introduced pollutants and their relationships to oceanographic variables present.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0091, SHIPBOARD METHODS OF CHEMICAL ANALYSIS

J.W. SWINNERTON, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

(1) To make shipboard evaluation of method for determining dissolved light hydrocarbons and carbon monoxide in sea water by gas chromatogrphy. (2) To adapt method for determining low-molecular weight hydrocarbons and CO in air over the ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0092, PRECISION MEASUREMENTS OF DISSOLVED OXYGEN, NITROGEN AND ARGON IN SEAWATER

D.E. CARRITT, Nova University, Graduate School, *Fort Lauderdale, Florida* (N00014-67-A-0386-0001)

The Navy needs to know the rate of ventilation of subsurface waters as it is pertinent to corrosion of structures; availability of 02 for isolated, long-term, undersea human habitation; and general ocean circulation. Gas exchange across sea surface has relevance to sea-air interaction and gas-membrane exchange phenomena.

The objectives are to obtain measures of the distribution of dissolved 02, N2 and Ar in the ocean by newly developed techniques which eliminate both systematic and accidental errors present in existing methods, and to use these measures as the basis for (1) describing the distribution of 02, N2, and Ar in the ocean; (2) establishing the departure (if any) of the gas solubility from predicted thermodynamic equilibrium; (3) elucidating the physical processes by which matter is transferred across the sea-air interface and (4) estimating the rate of ventilation of subsurface parts of the ocean. The system for gas measurements utilizes a sample bottle which captures a measured volume of sample in situ and upon recovery is attached directly to the analysis instrument. Analysis is with a gas chromatograph containing a 30-foot molecular sieve column, thermal conductivity detectors and built-in calibration systems based upon (a) coulometric generation of 02 or N2 and (b) injection of air or standard gas mixtures. Measurements will be made using Nova's research vessel and ships of opportunity for studies away from the U. S. East Coast.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0093, CHEMICAL METHODOLOGY - APPLICATIONS OF NITRATE SPECIFIC ELECTRODE TO CHEMICAL OCEANOGRAPHY

J.W. VANLANDINGHAM, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab., *Miami, Florida*

Objective: To study and evaluate various methods for reducing or nullifying choloride interference on the nitrate specific ion electrode, thus making a useful analytical tool available to chemical oceanography.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0094, DETERMINATION OF VOLATILE ORGANICS IN SEA WATER

J.F. CORWIN, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

Preliminary work by this investigator (1959-1963) has shown the feasibility of the use of Gas Chromatography for the separation and identification of volatile organic compounds in sea water. The principal problems encountered were sensitivity of the instrumentation, suitable stationary phases of the columns and a suitable method of removing the volatile materials from the water. Improvements in instrument manufacture, development of a new stationary phase by U. P. Schluneggar (1965) and the head-gas method of sample treatment indicates that the time is right for devising a good procedure for the analysis of low molecular weight organic content of sea water.

It is proposed to devote one year (sabbatical 1967-1968) to this problem. The success of this year will dictate the extent of effort to be devoted to the program in the future (after July 1, 1968). Dr. Corwin has been appointed Adjunct Professor by the Institute of Marine Sciences and has been offered space for the work.

SUPPORTED BY U.S. National Science Foundation

1.0095, THE GEOCHEMISTRY OF RADIOACTIVE ELEMENTS IN THE MARINE ENVIRONMENT - THE GEOCHEMISTRY OF LANDLOCKED SEAS

E. RONA, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124 (AT(40-1)2411)

The geochemistry of natural radioactive elements has been studied for several years at this Institute and elsewhere. Considerable contributions have been made in the use of radioisotopes for age determination and in the study of the geochemical conditions during and after the sedimentation process. Methods have been investigated and some have been further developed. We are of the opinion that specific areas of investigation will result in answers to some of the remaining questions.

Ocean sediments and sea water may, in principle, be dated by the radiochemical determination of certain members of the naturally radioactive disintegration series. Thus, Th-230/Pa-231 ratios may be used for dating ocean sediments and radium concentrations for sea water. The purely technical problems of measuring the activities of the actual isotopes are considered to be reasonably well solved. Despite quite extensive previous research, the assignment of age values on the basis of activity measurements is, however, badly hampered by lack of knowledge of the geochemistry of these isotopes; e.g., their chemical distribution at zero time, and the possible chemical and physical processes that could affect the distribution at a later time.

We therefore propose to try a different approach to these problems by investigating the geochemistry of the elements of the natural uranium-thorium series in landlocked seas where chemical conditions will differ, in some case extremely, from those in the open seas. In this connection, we also propose to extend the study to include barium, since its chemistry is similar to radium. Also included will be a comparison between C-14 ages and the uranium-series ages of some of the materials.

SUPPORTED BY U.S. Atomic Energy Commission

1.0096, THE EXTRACTION OF POTASSIUM FROM FRESH AND SALINE WATERS BY CLAY MINERALS

C.E. WEAVER, Georgia Inst. of Technology, Water Resources Center, *Atlanta, Georgia* 30332

The general objective is to determine how and to what extent the chemistry (particularly potassium) of fresh and saline waters is controlled by clay minerals and gels, both in the laboratory and in natural environments.

Using waters of various compositions, the ability of a variety of clay minerals to extract specific cations will be determined and the mean free bonding energies of the cations calculated. The release of interlayer clay water to the fluid will be measured and the factors controlling the return of adsorbed cations to the fluid phase as the chemistry of the water changes will be determined.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
Georgia Institute of Technology

1.0097, SOLUTION-SILICATE REACTIONS AND EQUILIBRIA

R.M. GARRELS, Northwestern University, Graduate School, *Evanston, Illinois* 60201

Studies of silicate-sea water reactions, of ground waters from igneous rocks, and of mass balance relations between rivers and oceans, have led to the conclusion that the gross chemical composition of the oceans represents a dynamic equilibrium between sea water and detrital silicates.

This proposal is to: (a) continue laboratory studies of the interaction between silicate minerals and sea water, with emphasis on reactions that remove cations and dissolved silica. (b) Perform experiments with various salt solutions and silicate minerals to permit equilibrium conditions to be predicted for sea water and allied fluids, such as pore waters of sediments. (c) Process published experimental data on silicates to obtain the best possible numbers for the thermochemical properties of the common silicate minerals. (d) Calculate the solution compositions and solids produced by progressive reactions between aqueous solutions and silicate minerals.

During these studies, it is proposed to continue to develop mass balance relations in the overall rock-water cycle in an attempt to elucidate the chemical history of the oceans.

SUPPORTED BY U.S. National Science Foundation

1.0098, CHRONOLOGY OF MARINE SEDIMENTS, CIRCULATION OF WATER AND TRACE ELEMENTS, SEDIMENTARY RECORD AND EXTRATERRESTRIAL ACCRETION

D. LAL, Tata Inst. of Fundamental Res. , *Bombay - Colaba, India*

Utilizing the technique of in-situ adsorption as an enrichment device, profile samples of a suite of trace elements in sea water were obtained for 20-3500 m depths at several locations in the Pacific ocean between Hawaii and New Zealand during the Nova expedition. The enriching matrix consisted of dispersed ferric-hydroxide suspended in natural spongin fibres. Several wide diameter gravity cores were also raised during this expedition. These samples will be analysed to study a host of crucial marine problems - nature of large scale circulation of water, trace element budget and sedimentary record of long term phenomena in relation to climatic changes and extra-terrestrial accretion of matter, using as tracers cosmic ray produced isotopes, Si-32, Be-10, Al-26, Mn-53 and those belonging to the U-Th series.

A profile sampler for ferric-hydroxide loaded spongin matrix and low level counting units for measuring alpha, beta and gamma activities at low levels have been developed for the above mentioned studies.

The fabrication of profile samplers and processing of spongin - matrix was carried out at the Scripps Institution of Oceanography, U.C.S.D., La Jolla. Analyses of recovered marine concentrates of trace elements and radioisotopes are being carried out at the Tata Institute of Fundamental Research, Bombay.

SUPPORTED BY Amer. Chemical Society

1.0099, CHEMICAL PROPERTIES OF SEA WATER AT PRESSURE

E.M. STANLEY, U.S. Navy, Ship Research & Dev. Center, *Annapolis, Maryland*

Objective: To determine those environmental factors affecting undersea uses of the oceans; to investigate pressure effects on the chemical properties of sea water.

Approach: Determine the characteristics of the seawater supply available for use in the pressure facility, both estuarine and off shore (including cooperative sampling and analysis work with ESSA and the Virginia Institute of Marine Science). Investigate solubilities of gases in sea water including Henry's law constants as a function of salinity, temperature and pressure for certain gases. Instrument development is inclined, such as one for sampling interstitial water in marine sediments which will bring the sample back under pressure for measurement of pH and other properties. Perform intra-laboratory consulting services on oceanographic factors.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0100, EXTENT OF BRACKISH WATER IN TIDAL RIVERS, MARYLAND

S.G. HEIDEL, U.S. Dept. of Interior, Water Resources Division, *Baltimore - Towson, Maryland*

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of Maryland.

Purpose: To delineate the boundary zone between brackish and fresh water and provide information to permit maximum utilization of the water in the tidal portions of Maryland rivers.

Methods: Location of the saline water front in all the inland tidal areas of Maryland at varying conditions of tide and runoff and different seasons of the year will be determined through use of continuous conductivity recorders, periodic spot measurements of chloride concentrations and determination of river profiles of salinities. A comprehensive report will be prepared on the extent and variation of the salt water encroachment in surface waters on the basis of these field observations and available supplementary information.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey
Maryland State Government

1.0101, MASS SPECTROMETRIC AND MANOMETRIC STUDIES OF THE OCEANS AND THE ATMOSPHERE

B.B. BENSON, Amherst College, Graduate School, *Amherst, Massachusetts* 01002

This research is a continuation of studies of dissolved gases which have great potential for the study of air-sea exchange phenomena, for the elucidation of processes occurring within the oceans, and for the determination of the past history of ocean waters. For this type of work very accurate dissolved gas measurements are required, and very accurate values for the solubilities of the gases must be known. Because the emphasis is on accuracy, the experimental procedures are described in detail.

During the first year, major activity will be focused on the determinations of the distilled and sea water solubilities of nitrogen, oxygen and the five noble gases, since these are necessary for the correct interpretation of oceanic data. At the same time, however, it is planned to complete and test sampling, processing and analytical equipment for the ocean measurements. The solubility work will be continued in the second year, but the emphasis will be shifted toward studies of the atmosphere and the oceans.

SUPPORTED BY U.S. National Science Foundation

1.0102, GEOCHEMICAL OCEANOGRAPHY

M. BLUMER, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

Work will continue on isolation and structural identification of organic compounds of marine organisms, whose production appears to be controlled by environmental factors, using a combined mass spectrometer -gas chromatograph. The movement of these compounds through the food chain and into the water masses will be studied.

Knowledge of the natural background occurrence of organic compounds in the sea is fundamental to development of means of detecting changes resulting from operations such as occupation of underwater habitats.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0103, ORGANIC COMPOUNDS IN THE SEA AND IN MARINE SEDIMENTS

M. BLUMER, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

Investigations will continue on the origin and fate of organic compounds in the sea and in marine sediments. Using techniques developed under an earlier grant, compounds of biochemical origin will be isolated from all components of the marine environment. Identification will be carried out by combined gas chromatography-mass spectrometry, and by nuclear magnetic resonance and infrared spectroscopy. Special emphasis will be placed on the study of biogenic hydrocarbons, lipids and selected polar compounds. The type and concentration of these compounds vary with the comparison of the plankton present in the water, with the time of the year, with the climate and with the history of the water mass. Thus, they should provide suitable tracers for the study of dynamic processes in the sea.

Selected derivatives of biochemical compounds will be isolated from deep marine, recent and ancient sediments. The structural comparison of these compounds with their biochemical precursors and their eventual conversion products will provide insight into the molecular processes in the subsurface.

SUPPORTED BY U.S. National Science Foundation

1.0104, RADIOELEMENT STUDIES IN THE OCEANS - LANTHANIDES IN SEA WATER AND THEIR INTERACTIONS WITH MARINE SEDIMENTS AND SUSPENSOIDS

V.T. BOWEN, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (AT(30-1))

Using activation analysis, individual lanthanides have been analysed in N. Atlantic sea water. Samples of N. Atlantic Deep Water (11), of Antarctic Bottom Water (3) and of Antarctic Intermediate Water (6) showed each water mass to have a characteristic and distinct profile of relative lanthanide element concentrations. Reported ACS Miami meeting 1967, and in press.

Carrier-free radioisotope studies show La, Y and Ce to react with standard clay minerals, marine sediments and open ocean suspensoids to give measurable and distinct K sub D values: on a gram per gram basis these range from 1 to 100 for APS standard clays, from 20 to 100 for open ocean sediments, and from less than 20 to 40 for open ocean suspensoids. Analysis of geochemical and oceanographic implications of this data is in process.

SUPPORTED BY U.S. Atomic Energy Commission

1.0105, SIGNIFICANCE OF FLUORIDE VARIATIONS IN SEA WATER

P.G. BREWER, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

Recent literature has indicated the presence of abnormally high fluoride/chlorinity ratios at depth in several stations in the North and South Atlantic Ocean. The source of the high fluoride has been tentatively assigned to volcanic activity associated with the Mid- Atlantic ridge. The research described in this proposal is intended to define the source of the fluoride and to determine its importance in understanding deep sea phenomena. We propose to develop a device to measure the fluoride/chloride activity ratio in situ and thus obtain a continuous record of the ratio with depth. During the Summer of 1968 the R/V CHAIN will make two crossings of the North Atlantic and the R/V ATLANTIS II a crossing of the South Atlantic. On each of these cruises we intend to obtain several profiles of the F-/Cl- ratio from the surface to the ocean bottom. The data obtained from these profiles will provide us with a measure of the extent of the fluoride enrichment with depth. Is this a localized phenomenon that may be associated with volcanic activity, or localized outcrops of fluorine rich minerals, or is it more widespread and possibly associated with the dissolution of particulate matter at depth? We also hope to obtain some indication of the value of the F-/Cl-ratio in tracing oceanic circulation at depth.

SUPPORTED BY U.S. National Science Foundation

1.0106, STABLE ISOTOPE STUDIES ON COEXISTING MINERALS IN MARINE SEDIMENTS

W.G. DEUSER, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

A study will be made of the distribution of the stable isotopes of oxygen and hydrogen among coexisting minerals in marine sediments and of the fractionation between the minerals and the interstitial and overlying waters. Samples to be investigated include those collected in and around the ATLANTIS and DISCOVERY deeps of the central Red Sea which are characterized by high salinities and temperatures ranging from 40 to 60 degrees C. The cores taken contain numerous easily identified minerals including various carbonates, oxides, sulfides and silicates, all of which appear to have formed syngenetically. Determination of the oxygen-isotope ratios in the different minerals and in the water samples coupled with the temperature measurements taken during sampling should reveal data on the mode of formation of the minerals. Knowledge of the water chemistry will aid in this effort. A comparison with the samples collected outside the hot deeps should reveal information on paleotemperatures and also on calcite-dolomite relationships at 20 degrees C. Additional determination of hydrogen- isotope ratios in hydrated minerals will serve as a further check on mode of formation and diagenetic changes of the minerals. A general study of hydrogen and oxygen isotope distribution as a function of depth in sediments will be made for individual minerals and mineral groups to determine the effect of diagenetic processes on isotope ratios.

SUPPORTED BY U.S. National Science Foundation

1.0107, ELECTROLYTE-NON-ELECTROLYTE INTERACTIONS IN SEA WATER AND RELATED SOLUTIONS

J.E. GORDON, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

This is a continuing program in which the firm base provided by the thermodynamic measurements on simple salt mixtures is used to extend investigation of thermodynamic properties of dissolved organic nonelectrolytes to more complex systems, approaching marine phenomena more specifically. These extensions require measurements on polar nonelectrolytes, which represent the bulk of organic constituents of sea water and of compounds of biological interest. They also require a deeper study of solubilization phenomena. The proposed plan of research includes these studies, but places emphasis on the second topic of the original proposal, marine chemical applications of proton magnetic resonance spectroscopy. Results on this half of the program are not as far advanced as the thermodynamic work, due principally to time invested in establishment of the experimental proton magnetic resonance facility. Detailed plans for pursuing the proton magnetic resonance investigation of water in mixed salt solutions, of organic nonelectroyletes in salt solution, and of aspects of the solubilization phenomenon, as well as employing the instrument in structure studies on organic compounds isolated from sea water--all with increased efficiency--are presented. One new topic of investigation is proposed- -evaluation of the marine chemical potentialities of the formation of insoluble complexes of alkali and alkaline earth metal salts on treatment of their aqueous solutions with liquid CBr2(CN)2. Suggested applications are removal or fractionation of sea salt and use in trace element determination.

SUPPORTED BY U.S. National Science Foundation

1.0108, STABLE ISOTOPES

J.M. HUNT, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

Profiles will be made across the North Atlantic and South Atlantic, and C13/C12 ratios will be measured in both the dissolved organic carbon (DOC) and inorganic carbon (CO2). The DOC will be photo-oxidized by UV irradiation and the CO2 produced caught for analysis in the mass spectromenter. C13/C12 ratios in DOC will be compared with values already established for various components of marine life.

Knowledge of distribution of natural variations of isotope ratios in sea water is an important prerequisite to evaluation of man-made variations resulting from test or employment of weapons or operations of vehicles. Program also contributes to overall understanding of mixing rates and turbulence in the ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0109, DISTRIBUTION OF CARBON AND RADIUM IN THE ANTARCTIC WATERS

T. KU, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

Woods Hole Oceanographic Institition will collect and analyze water samples from the southern oceans for several dissolved elements and gases. Samples will be taken on Eltanin

Crusie 35 in the South Australia Basin of the Indian Ocean at 10 stations. Each station sample series will consist of ten 20-liter Nisken bottle samples, one from the surface and nine from predetermined depths. The concentration and isotopic composition of the dissolved inorganic carbon, and the partial pressure of carbon dioxide, will help to identify surface water, as distinguished from Antarctic bottom water. The method using an infrared gas analyzer has been shown to be more accurate and sensitive as compared to the pH and alkalinity methods employed previously on other research projects. The determination of dissolved oxygen, and the ration of carbon-12 to carbon-13 of the dissolved inorganic carbon, will help to better understand the oxidative processes of the organic compounds present. The heavy radioactive metals, radium and uranium, will also be determined for various depths in order to evaluate the role played by the biota in the vertical distribution of heavy elements in the water column.

The shipboard collecting and analyses will be carried out by a marine geochemist from Lamont Geological Observatory. No personnel from WHOI will be on board the Eltanin during Cruse 35.

SUPPORTED BY U.S. National Science Foundation

1.0110, ANALYSIS OF SEA WATER BY DIFFERENCE CHROMATOGRAPHY

P.C. MANGELSDORF, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (AT(30-1)3838)

The objective of this research is to use the method of ion exchange difference chromatography to study slight variations in the proportions of major elements in sea water. The method in its present form has been shown to be sensitive to differences in the K plus/Na plus and Ca plus/Na plus ratios in sea water of the order of one part in 10 to the 5th power. We will attempt to increase the sensitivity by a factor of 10 in the expectation that well-defined reproducible variations of these and other ratios can be found in water samples from various sources. In particular we are interested in the vertical variations of composition in the deep sea water column, in the effects of run-off on the salt composition of coastal waters, and in the composition in interstitial waters trapped in recent sediments.

SUPPORTED BY U.S. Atomic Energy Commission

1.0111, ORGANIC MATTER

D.W. MENZEL, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

Water will be sampled on a cruise from North to South Atlantic and then across the South Atlantic to determine relationships between dissolved organic carbon (DOC) and oxygen depletion in the water masses. Samples will be closely spaced (50 m.) in regions of oxygen and salinity minima. Nitrate and phosphate will also be determined. Significance of dissolved oxygen as a conservative property will be evaluated.

If the quasi-conservative nature of dissolved oxygen can be established, and if it can be demonstrated that DOC content of a water mass is determined in the surface layers, oceanographers will have powerful new tools for identifying water masses and investigating mixing processes and large scale turbulence and water motions in the ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0112, THE CYCLE OF ORGANIC MATTER IN THE DEEP SEA

J.H. RYTHER, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (AT(30-1)3862)

A study will be made of the origin, distribution, composition and fate of the particular matter in the sea, with emphasis on the non living, organic fraction (i.e., detritus). Major emphasis will be placed on determining the flux of this material through the marine ecosystem by investigating its relationship to primary and secondary organic production, its rate of decomposition, its seasonal, geographical, and vertical distribution in the sea, and its rate of sinking and decomposition on the bottom. The ecological significance of the particulate matter will also be investigated with respect to its ability to scavenge dissolved organic matter by surface adsorption, its role in providing a surface for bacterial growth, and its value as food, both directly and indirectly through the use of organic matter adsorbed to or growing on its surface. The possibility that detritus in the deep-sea represents a stable, refractory, and neutrally buoyant reservoir of organic matter, as indicated by recent evidence, will be examined in detail through intensive distributional studies, laboratory experimentation, and isotope dating techniques.

SUPPORTED BY U.S. Atomic Energy Commission

1.0113, ELEMENT CHEMISTRY

D. SPENCER, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

The purpose of this task is to determine the distribution and concentration of dissolved metals in the oceans. The work involves careful sampling from ships, to avoid contamination, and subsequent analysis in the laboratory using atomic absorption spectroscopy.

Knowledge of the natural background levels of concentrations of metallic ions in sea water masses is fundamental to the development of means of monitoring man-made changes in these levels through military or industrial activity.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0114, HETEROTROPHIC ACTIVITY AND PRIMARY REGENERATION IN THE OCEAN

R.F. VACCARO, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

The amount of surface oriented dissolved organic carbon in the ocean is relatively large in terms of the remainder of the water column and varies according to the rate of biological recycling. Within photic depths both labile and refractory forms of carbon are prominent since organic reproduction and degradation proceed simultaneously. At intermediate depths further decomposition may occur following sinking and the advection of particulate organic residues but ultimately throughout the remaining and deeper portions of the water column dissolved organic carbon remains remarkably constant. Inability in the part to demonstrate significant biochemical oxidation within the deep ocean suggests that most of the organic material is present in a refractory form capable of prolonged resistance to biological decomposition.

The bulk of this deep refractory organic carbon appears in the form of macromolecules believed to be structured on linkages provided by polyphenols, quinones or amino acids. In this regard our current efforts include a shipboard application of charcoal adsorption designed to fractionate and quantatively evaluate the importance of residual organic carbon in the sea. Observations so far completed include a transatlantic crossing from Barbados to the Cape Verde Islands as well as samplings in the deep and shallow waters of the Gulf of Mexico proximal to the Yucatan Peninsula. The pattern emerging is that between 70 to 90 percent of the deep dissolved organic carbon at midoceanic locations is present as organic condensates which appear to occupy a quasi-terminal position in the organic cycle of the sea. At river outlets, in coastal waters, and in adjacent seas such as the Gulf of Mexico, the fraction of residual organic material is significantly less.

SUPPORTED BY U.S. National Science Foundation

1.0115, CHEMISTRY OF THE HYPOLIMNION OF LAKE ERIE

H.E. ALLEN, U.S. Dept. of Interior, Biological Laboratory, *Ann Arbor, Michigan*

During the period of summer stratification much of the hypolimnetic water in Lake Erie experiences severe oxygen depletion. Concurrent large changes occur in the concentration of nitrate, ammonia, phosphate, iron, maganese, and sulfide. Our objectives include describing the magnitude and rate of these changes, determining the chemical compounds involved and determining the effects of these changes on the ecosystem. Subsequent to fall overturn concentrations of these materials return to those concentrations existing prior to stratification. Field studies are being made to determine the concentrations of these and other substances in the waters. Laboratory studies are being conducted to determine the oxidation-reduction potential at which materials are released from the sediments and to determine the kinetics of their buildup in the water. The chemical composition of materials precipitated upon overturn is being investigated. Various sediments are being investigated to determine the substances responsible for oxygen depletion.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0116, CHEMICAL CHARACTERISTICS OF THE GREAT LAKES

J.F. CARR, U.S. Dept. of Interior, Biological Laboratory, *Ann Arbor, Michigan*

The long-range objectives are to gain an understanding of the cycles of the major nutrients in the Great Lakes and connecting waters and their influences on the productivity of the lakes. Objectives are to demonstrate the vertical, horizontal, and seasonal variations in water quality in various habitats of the lakes. Routine determinations are being made on a variety of Great Lakes waters for sodium, calcium, magnesium, potassium, sulfate, chloride, silica, alkalinity, pH, dissolved oxygen, and total phosphorus.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0117, MINERAL-WATER CHEMISTRY, GREAT LAKES

J.R. KRAMER, Univ. of Michigan, Great Lakes Research Division, *Ann Arbor, Michigan*

Great Lakes chemistry, relative to major ions, is evolved from a time independent invariant chemical equilibrium model(s). The ability to rigorously define these models rests upon knowing free energy expressions for the specific minerals and aqueous ligands, the crystallography and stoichiometry of the minerals, and the in situ chemistry of the Great Lakes.

Solution equilibrium among end member solid phases permits determination of free energy of formation of the common minerals. This procedure is applied to synthetic simple composition minerals and naturally occurring minerals. Equilibration is considered attained when identical results are achieved for different paths of equilibration.

Standard chemical, X-ray diffraction, and optical techniques are used to define solid phases. Knowing specific solid phases allows one to 'equilibrate' the entire specimen and compare results with those predicted by single solid phase equilibrium studies.

Ultimate goodness of fit is achieved by comparing apparent equilibrium expressions obtained from data for the Great Lakes to the above models. Since parts or all of the Great Lakes are not in the same environment as the analytical laboratory, emphasis must be placed upon in situ or pseudo in situ analyses.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

1.0118, MINERALOGICAL CONTROLS ON THE CHEMICAL COMPOSITION OF OCEAN WATER

H.D. HOLLAND, Princeton University, Graduate School, *Princeton, New Jersey* 08540

Although it is almost certain now that the chemical composition of ocean water is strongly influenced by reactions of ocean water with silicate minerals, the nature and the geography of these reactions are very inadequately known. This grant is for the study of the interaction of clays with ocean water in the field and in the laboratory.

Preliminary work in the vicinity of Puerto Vallarta, on the Pacific Coast of Mexico, has shown that a good deal of the area is underlain by rhyolites and andesites and that essentially none of the clays in soils and in the rivers is inherited. It is intended to study the mineralogy of soils in this area, the chemistry of at least one of the rivers from its source to its estuary, the mineralogy of river sediments, and the mineralogy of sediments in estuaries and just off-shore.

At the same time it is planned to do some exploratory work on the fate of iron which is brought to the Atlantic Ocean in great abundance by a number of New Jersey rivers. There is some evidence that Fe2O3.nH2O reacts to form silicates containing abundant Fe 3 during the diagenesis of marine sediments, which makes it desirable to see how much and how rapidly iron-rich clay is formed in near-shore environments.

SUPPORTED BY U.S. National Science Foundation

1.0119, OXYGEN RESOURCES OF TIDAL WATERS

J.P. BARLOW, State University of New York, Agricultural Experiment Sta. , *Ithaca, New York* 14850

The objective of this project is to evaluate the potential sources of oxygen in tidal waters which may be subjected to organism pollution. The study is presently concerned principally with regions in which horizontal exchanges are so restricted that the ocean is a relatively minor source compared with plant photosynthesis and atmospheric reaeration. Photosynthetic production of oxygen will be evaluated by means of direct experimental methods, and atmospheric reaeration from an analysis of time-changes in concentration effected by diurnal changes in biological processes. It is hoped thereby to obtain some understanding of the influence of hydrographic and biological factors on the reaeration of these regions.

SUPPORTED BY New York State Government

1.0120, INVESTIGATIONS OF URANIUM AND THORIUM SERIES ISOTOPE DISEQUILIBRIUM IN THE OCEAN AND IN PLEISTOCENE SEDIMENTS

W.S. BROECKER, Columbia University, Graduate School, *Palisades, New York* 10964 (AT(30-1)3139)

This research is primarily a study of the conditions which bring about disequilibrium among the isotopes of the U and Th series in nature with an eye toward developing methods of age determination. Thus we are trying to date water masses by studying the distribution of Ra-228, Th-228, Pb-210, Po-210 and Ra-226, oceanic sediments by measuring Th-230 and Pa-231 and pluvial lake salts and volcanic ashes by measuring Th-230, Th-232 and uranium. At the same time, these studies lead to a better understanding of the geochemical behavior of these elements. By applying these methods we are tyring to answer the following questions of importance to earth science: 1) what is the source of the high concentration of unsupported Ra-228 in ocean water? 2) is the distribution of Pb-210 surface ocean water controlled by the input of atmospheric Pb-210? 3) do the times of the sharp cold to warm climate changes as seen in deep sea sediments support the astronomical theory of glaciation? 4) how is the timing of pluviation related to the time of glaciation?

SUPPORTED BY U.S. Atomic Energy Commission

1.0121, GEOCHEMICAL STUDIES OF CONTINENTAL WATERS

W.S. BROECKER, Columbia University, Graduate School, *Palisades, New York* 10964 (AT(30-1)2493)

The purpose of this research is to gain an understanding of the factors controlling the major element chemistry of continental waters. We are contrasting the chemistry of three closed basin saline lakes, a sulfate-rich meromictic lake, and its associated ground waters, two fresh water lakes, lakes within active volcanic regions and subsurface waters in an island coral cap. Measurements of the major elements, pH, and pCO are being made on the lake waters, river and ground waters supplying the lakes, and pore waters extracted from the lake sediments. Stable and radioisotopes (C-14, C-13, Sr-90, Cs-137, Rn-222, ...) provide useful means of tracing sources and determining residence times. The origin of the detrital and authigenic phases in the sediments is also being studied.

A report regarding our study of Green Lake is in press (Limnology and Oceanography). Preliminary reports on our saline lake studies appear in this years Project Report.

SUPPORTED BY U.S. Atomic Energy Commission

1.0122, MINERALOGICAL STUDIES OF PARTICULATE MATTER SUSPENDED IN SEA WATER

JACOBS, Columbia University, Graduate School, *Palisades, New York* 10964

The purpose of this study is to establish the mineralogical and chemical nature of particulate matter suspended in sea water. A world- wide sampling program, now in its second year, has produced surface and deep sea water samples of suspended particulate matter, along with samples of corresponding bottom sediment. X-ray diffraction and spectrographic techniques will constitute the principal analytical procedures to yield mineralogical and chemical data for suspended particulate matter in ocean water.

Little is known about the nature of the mineral particles suspended in sea water; even quantitative information of the most basic nature is wanting. Although most of the mineral content of suspended particulate matter has been derived from the weathering of land masses, there is a possibility that an authigenic component of significant magnitude forms within the sea. It is significant to understand the relative importance of these two components. Also, information is needed regarding the changes the land-derived minerals undergo in sea water, as well as their settling times. A widespread layer of cloudy water near the ocean bottom has been discovered, and there is a possibility that this represents an additional means of transport for large quantities of sediment.

SUPPORTED BY U.S. National Science Foundation

1.0123, DISSOLVED ORGANIC PHOSPHORUS IN NATURAL WATERS

E.J. KUENZLER, Univ. of North Carolina, School of Public Health, *Chapel Hill, North Carolina* 27514 (AT(40-1))

The objectives of this proposal are to continue seeking techniques for identification of the major components of the dissolved organic phosphorus (DOP) pool in natural waters, to investigate the seasonal distribution of DOP compounds, and to examine the nature of the DOP eliminated into the medium by cultures of planktonic algae. The geographical and seasonal changes in total DOP are partially known but the chemical compounds making up these pools are completely unknown. Prior work has shown that the DOP present in natural sea waters consists of several important components. The DOP eliminated by healthy algae in pure culture also consists of several components but it is not yet known whether these are the same as occur in natural waters. This project began in 1965 and should be completed in 1970. To date methods have been developed for concentrating, purifying, and separating organic phosphorus compounds from natural waters and from unialgal cultures. Radioactive phosphate in culture media is taken up by algae and partially eliminated as labeled DOP. This permits measurement of rates of DOP elimination under various environmental conditions. The next steps are the final identification of these compounds, the delineation of their spatial and seasonal distributions, and investigation of their ecological significance.

SUPPORTED BY U.S. Atomic Energy Commission

1.0124, STRONTIUM ISOTOPE COMPOSITION AND TRACE ELEMENT CONCENTRATIONS IN LAKE HURON AND ITS PRINCIPAL TRIBUTARIES

G. FAURE, Ohio State University, Graduate School, *Columbus, Ohio* 43210

Concentrations of the major cations: Na, K, Ca, and Mg and Sr were determined for 64 samples of surface water from Lake Huron and for 17 of its major tributary rivers. For addition, isotopic compositions of strontium were measured for 30 samples of lake water and for 13 of the tributary rivers. Concentrations of dissolved iron and total phosphorous were determined for a small suite of lake and river water.

The data documents important differences in the chemical composition of water discharged into Lake Huron by Lake Superior, Lake Michigan and tributary rivers. These differences are related to differences in the chemical and mineralogical composition of the bedrock underlying the Great Lakes drainage basin.

The strontium contributed to Lake Huron by water draining the Canadian Shield along its northern shore is enriched in radiogenic Sr87. The average Sr87/Sr86 ratio is 0.718. The rivers draining sedimentary rocks of Michigan and southwestern Ontario contribute strontium whose isotope composition is similar to that in the modern oceans and has a Sr87/Sr86 ratio of 0.710.

A geochemical model is presented which attempts to represent the chemical composition of water in Lake Huron as a mixture of the different types of water discharged by different sources.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
Ohio State University

1.0125, CHEMICAL FEATURES OF THE SUBARCTIC BOUNDARY IN THE NORTHERN PACIFIC OCEAN

K. PARK, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

It is proposed to study the chemical features of the unique oceanographic phenomenon in the North Pacific, the confluence of Subarctic and Subtropic waters. The four specific objectives are: (1) Chemistry of the subarctic boundary - to investigate the chemical make-up and history of the Subtropic and Subarctic waters near the Subarctic Boundary. The data arising will help to understand the nature and mixing of the two water masses as they move eastward from near Japan. (2) Deep-sea chemical properties near the Subarctic Boundary - to study the deep-sea gas nutrient interrelationships underneath the Subarctic Boundary. (3) CO2 Sink near the Subarctic boundary - to learn about the air-sea exchange of CO2 over both the Subarctic and Subtropic regions. (4) Chemical reference for hydrochemical data from the Subarctic boundary - to establish a reference to intercompare the hydrochemical of Japan, U.S.S.R., Canada, and the U. S. already obtained from the Subarctic boundary region. Three cruises are planned for the study. The first cruise is for a study of the microstructure of the boundary; the second to establish a chemical-conditions reference for winter; and the third is for an intensive study of the entire Subarctic boundary region from near the west coast of the U. S. to Japan. These studies will contribute to the national oceanographic program by providing important information for an understanding of the complex features of the North Pacific.

SUPPORTED BY U.S. National Science Foundation

1.0126, CHEMICAL PROPERTIES OF SEA WATER AND THEIR USE IN STUDIES OF WATER MASSES AND MIXING

R. PYTKOWICZ, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Objective: The increasing use by the Navy of relatively permanent surface, subsurface, and bottom-mounted installations in both its R&D and its operational activities requires a better understanding of the chemically corrosive environment in which these activities occur. This research is providing fundamental information on the chemical properties of sea water in the NE Pacific, on the variability of these properties in space and time, and on the chemical changes across the air-water and water-sediment interfaces. In addition, this same information is being used in studies of water mass movements, and diffusion and mixing processes.

Approach: Shipboard field-observation programs will be carried out to determine the distributions and concentrations of carbon dioxide, oxygen, phosphates, nitrates, and silicates during the winter months when upwelling is absent and again during the spring and summer when upwelling is present. The amount of dissolved gas in the upwelled water mass should be a distinctive property and will be used to trace the downward and seaward motion of this water mass after it leaves the upwelling area.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0127, RESEARCH ON THE PHYSICAL CHEMISTRY OF CHEMICAL REACTIONS IN SEA WATER

R.M. PYTKOWICZ, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

A study will be made of the application of the newly determined apparent dissociation constants of phosphoric acid in sea water to revise existing data on the solubility of apatites and to compare these data with ionic products in the oceans.

The determination of the apparent dissociation constants of carbonic and boric acids will be extended to 1,000 atmospheres and 0 degrees C.

A study will be made of the solubility and rates of solution of foraminifera in sea water as a function of pressure to verify earlier data on simpler solid phases and to better understand the compensation depth.

Complexes formed by ions in sea water will be studied over ranges of temperature and pressure that reproduce conditions found in the oceans. Initial emphasis will be on sulphate complexes and, if time permits, bicarbonate and carbonate complexes will also be studied.

SUPPORTED BY U.S. National Science Foundation

1.0128, MARINE BIOLOGY PROGRAM

F.G. LOWMAN, Univ. of Puerto Rico, U.S. Aec Pu. Ri. Nucl. Ctr. , *Mayaguez*, *Puerto Rico*

In this program, begun at PRNC in Jan. 1962, the distribution and movements of trace elements is being studied in restricted but complete ecological and biogeochemical systems in river basins and offshore along the western coast of Puerto Rico. The program is concerned with coordinated investigations of selected trace elements, with analyses; concentration factors in selected organisms for particular radionuclides; the marine ecosystem; biological productivity; studies of the physical, chemical, and geological oceanography of the west coast of Puerto Rico, and distribution patterns of rare earths in the Anasco River watershed, the neighboring marine waters, the organisms and sediments.

Published results include papers on stable scandium as determined in sediments, soils and minerals by neutron activation analysis; distribution of trace elements in the marine environment; effects of river outflow on the distribution pattern of fallout radionuclides in marine organisms; distribution and partitioning of Fe, Zn, Sc, and Sm within the benthic community of Anasco Bay, P.R.; trace element composition in inshore and offshore populations; uptake of Zn65 by marine algae, etc.

SUPPORTED BY U.S. Atomic Energy Commission

1.0129, CHEMICAL OCEANOGRAPHY

J.T. CORLESS, Univ. of Rhode Island, Graduate School, *Kingston*, *Rhode Island* 02881 (NONR)

This task includes studies in the following areas of chemical oceanography: (1) rare earth geochemistry to provide insight into mechanisms of sea floor evolution; (2) trace elements content of sea water and phytoplankton; (3) organic phosphate substances in sea water; (4) biochemistry of silica; (5) effect of pressure on biochemical processes.

Trace element concentrations in sea water give promise as a tool for understanding the circulation and dispersion of materials in the oceans. The fraction of these elements in ionic and in bound forms needs to be understood if full advantage is to be taken of this tool as a water mass tracer. The pressure effects on biochemical processes are pertinent to the Navy's saturated diving programs such as 'Man-in- the-Sea.'

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0130, AN INVESTIGATION OF TRITIUM IN RAIN WATER

E. ERIKSSON, Stockholms Universitet, *Stockholm*, *Sweden* (AT(30-1)2458)

The objective of the proposed work is to continue the study of the meteorological factors which influence the distribution in time and space of tritium in rainwater and in atmospheric moisture.

The scientific background to this problem is the observed fact that the distribution of tritium in precipitation differs substantially from that of e.g. Sr90 although at present their sources are common. This difference can be expected because tritium appears as a part of the water molecule and may be taken advantage of as an aid in understanding certain parts of the circulation of water in nature.

The procedure to be adapted is to collect all available data and study their geographical distribution at various times and further, if possible, to relate this distribution to the transport pattern of atmospheric water vapor. Further, to aid the interpretation, studies of the vertical distribution of tritium in atmospheric moisture will also be carried out, both in continental environment and in maritime environment.

So far, it has been concluded from past years' studies that a considerable transfer of tritium from the atmosphere to the oceans takes place through mass exchange between the sea surface and the atmosphere and that this transport is about two times larger than the transport by precipitation. This mass exchange which does not apply to e.g. Sr90 explains in a qualitative way the present geographical pattern of tritium in precipitation.

SUPPORTED BY U.S. Atomic Energy Commission

1.0131, CHEMICAL OCEANOGRAPHY

E.R. IBERT, Texas A & M University System, Graduate School, *College Station*, *Texas* 77843 (NONR)

This task involves studies into the methods of recovery, analysis and age dating of dissolved and particulate, organic matter in the Gulf of Mexico and Caribbean, leading to determinations of its origin, distribution and fate. Efforts include the extraction of organic carbon from sea water aboard ship in quantities sufficient for carbon- 14 age determinations.

Organic materials in sea water are responsible for surface films and it is becoming evident that these compounds have a finite influence on many of the inorganic chemical reactions taking place in the oceans. This program will provide basic information necessary to the understanding of these phenomena.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0132, STABLE CARBON AND OXYGEN ISOTOPE RATIO VARIATIONS IN THE FLOW TO CARBON AND OXYGEN THROUGH NORMAL AND POLLUTED AQUATIC SYSTEMS

P.L. PARKER, Univ. of Texas, Graduate School, *Port Aransas*, *Texas* 78373

The main goal of the proposed research is to develop ways to use measured variations in stable carbon and oxygen isotope ratios to solve problems concerning the flow of these elements in aquatic systems. By investigating both normal and polluted systems a better understanding of both will result. Rivers, lakes and marine bays are aquatic systems which would be studied. However, single species of organisms, sewage systems and industrial plants also have a flow of carbon and oxygen and would be suitable for study.

In addition to the stable isotope studies the total amount of dissolved and particulate organic matter in area waters will be investigated. The organic geochemical studies which have been conducted here for the past three years will be continued.

SUPPORTED BY U.S. National Science Foundation

1.0133, PHYSICAL AND RADIOLOGICAL CHEMISTRY OF OCEAN SOLUTIONS

R.W. PERKINS, Battelle Memorial Institute, *Richland*, *Washington* 99352

The many radionuclides from fallout, cosmic ray spallation, reactor waste disposal and natural sources, although at extremely low concentrations, are excellent tracers for physical studies of the oceans. Hanford techniques of sufficient sensitivity are available. When combined with neutron activation analysis, these make possible studies of the trace elements present in oceans and the reactions in which they participate. The chemical processes in the oceans, the existing chemical equilibria, and the reaction rates and mechanisms will be studied. The behavior of fallout material and of low level radioactive tracers will be clarified. The various forms - ionic, colloidal, chelate, particulate, or incorporated into biological material will be determined. Automatic equipment will be installed and used on oceanographic research ships.

Studies of radionuclide and trace element concentrations, physical and chemical forms were made on the Oregon coast and across to Hawaii. Mn-54, Co-60, Ru-106, Cs-137 and Ce-144 increased two-to threefold in the first half of the voyage then decreased to about one-half of the west coast concentration at Hawaii. Cs-137 up to 500 miles off the California coast showed relatively uniform surface concentrations dropping to 2 to 3% at 300 meters. A study of contamination associated with sampling led to improved techniques; an all-plastic sampler was built. Trace elements were simultaneously determined in organisms by neutron activation and multidimensional gamma-ray spectrometry. Squid and lantern fish concentrate Ag. Neutron activation proved useful for trace elements in deep sea sediment.

SUPPORTED BY U.S. Atomic Energy Commission

1.0134, CHEMICAL OCEANOGRAPHY

T. JOYNER, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

Phase I. Development and evaluation of techniques for the measurement of trace elements in sea water and marine organisms.

Phase II. Application of trace element measurements to the detection of heterogeneity in water masses and the determination of the patterns of circulation and mixing in coastal and oceanic waters.

Phase III. Evaluation of the effects of variations in environmental proportions of trace elements on the production and ecological organization of marine life. This will be based upon (1) controlled experimentation in laboratory cultures and (2) direct observations made at sea.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0135, STUDIES OF OXYGEN-FREE, SULFIDE-BEARING MARINE ENVIRONMENTS

F.A. RICHARDS, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The observations will be designed to elucidate the following unique features of anoxic environments: (1) Dentrification, with the removal of nitrate and nitrate ions and the production of N2; (2) Sulfate reduction, with the production of sulfides and other reduced forms of sulfur and the occurrence of low redox potentials; (3) Anerobic fermentation with the production of methane and possibly other hydrocarbons and hydrogen; (4) Extraordinarily large concentrations of carbonates in solution, high alkalinity values and low pH values; (5) The accumulation and preservation of relatively large concentrations of organic matter in the sediments, which are not reworked because benthic organisms are eliminated by the sulfides; and (6) The maintenance in solution or the authigenic precipitation of metals and metal sulfides.

Laboratory studies will be carried out to investigate (1) A stoichiometric model for the decomposition of organic matter in the sea in general and especially in anoxic environments; (2) A mathematical model for the vertical distribution of organic decomposition products, of sulfides, and dissolved oxygen which accounts for interactions between sulfides and oxygen; (3) The effects of the conditions in these environments on the alkaline components; (4) The kinetics of reactions between solutions of oxygen and sulfides, and (5) The effects of sulfides and low oxidation-reduction potentials on the solubility of metals and their solid phases.

SUPPORTED BY U.S. National Science Foundation

1.0136, CHEMICAL STUDIES OF THE OCEANIC ENVIRONMENT

F.A. RICHARDS, Univ. of Washington, Graduate School, *Seattle, Washington* 98122 (NONR)

Objective: The Navy's man-in-the-sea activities and underwater development of systems and equipment require fundamental knowledge of the occurrence in the sea of reducing substances, toxic gases and trace metals in order to be able to understand and predict their effects on both man and objects. This investigation of the chemistry of the Pacific Ocean includes the chemical tracing of water masses; the chemical control on the biological regime and its effects on plankton and other sound scattering organisms; the chemistry of oxygen-deficient environments; and the chemistry of trace metals observed in a variety of environmental influences.

Approach: This is a field and laboratory investigation to determine and explain the distributions of the chemical constituents of sea water. Both quantitative and qualitative analyses are being made of water samples collected from different oceanic areas. Comparisons are being made of the waters off the Washington and Oregon coasts where the Columbia outflow and upwelling occurs and in contrasting biologically poor and rich ocean regions of Central America and Peru. The trace metal content of waters in the Peru Trench and Mexican Trough is being measured as a means of determining age, transport, rate of replenishment and exchange of these waters.

SUPPORTED BY U.S. Dept. of Defense - Navy

1C. ELECTRICAL PROPERTIES

1.0137, INDUCTION IN THE OCEAN

C.S. COX, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038 (NONR)

The objective of this research is to measure electric and magnetic field variations at the ocean bottom and to infer from these data something about: (1) large-scale watermass motions, and (2) the composition and thermodynamic properties of rocks in the earth's upper mantle. Techniques and equipment for making the required measurements are being developed and tested. Special measurement programs on the geo-magnetic equator are planned for this year off the coasts of Peru and India.

Information concerning fluctuations in the earth's magnetic field requires an understanding of the interrelations between the geo-magnetic field variations and ocean currents. In addition, the potential use of the earth's crust as a transmitting medium for communications purposes is presently being explored. Evaluation of this potential use requires information about the electrical properties of the earth's crust and upper mantle. This program will help provide such information and understanding.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0138, ELECTROMAGNETIC NOISE MEASUREMENTS IN THE SEA

M. GINKLE, U.S. Navy, Underwater Sound Lab. , *New London, Connecticut*

To measure electromagnetic characteristics of the ocean. Measure electromagnetic noise at the surface of the sea and in the sea as a function of frequency, time, weather, geographic locations, ocean depth and proximity to the bottom and shore line.

Approach: Surface Ship Measurements - Measure simultaneously the electromagnetic noise in the atmosphere immediately above the sea surface and the noise in the sea to depths of 200 feet using surface vessels as measuring platforms. Deep Research Vehicle Measurements - Measure electromagnetic noise in the sea at depths greater than 200 feet using underwater research vehicles (DRV's) as measuring platforms.

Ocean Bottom Measurements - Measure electromagnetic noise near and at the bottom of the sea using the ocean bottom or moored buoys as the measuring platform.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0139, MEASUREMENT AND INTERPRETATION OF MOTIONALLY-INDUCED ELECTRIC FIELDS IN THE SEA

T.B. SANFORD, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241))

Measurements of changes in the oceanic environment are necessary to the development of environmental prediction networks. This research should develop means of continuously monitoring the transport of water by ocean currents over long time periods, thereby providing measurements of one key environmental parameter.

This work is concerned with the interpretation of measurements of electric and magnetic signals which are caused by oceanic flow. The effort mainly consists of a series of related field experiments. In order to obtain continuous information about the flow between widely spaced current meters, electrodes are being developed for attachment to the same moorings as the current meters. The potential difference between electrodes gives a measure of the volume of water flowing between them. Using electrodes attached to a submarine cable crossing the Florida Straits, between Jupiter Is., Fla. and Grand Bahama Is., a very long time series of fluctuations in the flow through the Straits will be obtained and interpreted in terms of natural phenomena. It is expected that this information will aid developing a predictive model of this flow.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0140, CRITICAL TABLES ON THE ELECTROCHEMICAL PROPERTIES OF INTERFACES

J. LYKLEMA, Landbouwhogeschool, *Wageningen, Netherlands*

The properties covered in this project are the capacitance or charge of the electrical double layer, electrocapillarity curves, electrokinetics including surface conductance and points of zero charge for all well-defined species that can be obtained reproducibly.

Three reports have been received: an uncritical compilation of references in December 1965, a first selection of the references in October 1966, and recently a report containing a first selection of critically evaluated data. Included were a) double layers on systems other than metals, mercury or semiconductors; b) electrokinetic properties such as electrophoretic mobilities, streaming potentials and electroosmosis; c) points of zero charge. The data will be critical reference data of wide use in the study of natural and manufactured colloidal systems and of interfaces in electrolytic solutions such as seawater.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1D. GENERAL AND MISCELLANEOUS PROPERTIES

1.0141, OCEAN DYNAMICS IN THE STRAITS OF GIBRALTAR AND ADJACENT AREAS

T. LAVASTU, U.S. Navy, Postgraduate School, *Monterey, California* 93941

To determine those environmental factors affecting acoustical uses of the ocean; to categorize strategic areas into similar acoustical provinces. To provide scientific background knowledge for improvement of synoptic oceanographic analyses/forecasting models which provide environmental support to submarine and antisubmarine warfare forces.

Study tidal, synoptic, seasonal and secular changes in oceanographic conditions in the Strait of Gibraltar and adjacent seas and make a dynamic computerized model. Procure all available hydrographic data from the area in cooperation with the Spanish Oceanographic Institute (SOI) and analyze at FNWF using existing computer programs. To monitor the flow into and out of the Mediterranean by measuring the potentials in telephone cables across the Strait.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0142, OCEANOGRAPHIC RESEARCH

E.C. LAFOND, U.S. Navy, Undersea Warfare Center, *San Diego, California* 92140

Objective: To determine those environmental factors affecting acoustical uses of the ocean, to predict the effects of variability in properties of the surface layers of the sea affecting salinity, sound speed, microbubbles, gas content. Chemical and biological (except sound scattering) factors, water motion (orbital, tidal, turbulence, internal waves) and other dynamic processes; to observe and develop theory and models for predicting underwater sound propagation using deep ocean water paths including near-bottom phenomena.

Approach: Collect physical oceanographic data over depth time and space using the NUWC Oceanographic tower, buoys, ships, airplanes, deep submersibles and bottom mounted equipment to investigate the nature of changes in thermal structure, water density, chemistry and motion as related to underwater acoustics; obtain descriptive and statistical relations between thermistor chain data and geographic location, depth of water, tide currents, upwelling, island wakes, water masses, storms, seasonal and biological growth data; conduct deep sea expeditions and joint investigations with other nations.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0143, OCEANOGRAPHIC RESEARCH - INVESTIGATIONS WITH THERMISTOR CHAIN

O.S. LEE, U.S. Navy, Undersea Warfare Center, *San Diego, California* 92140

Objective: To determine those environmental factors affecting acoustical uses of the ocean. Observe and develop theory models for predicting underwater sound propagation using deep ocean water paths. Develop theory to predict water motion, especially internal waves in the deep ocean.

Approach: Obtain descriptive and statistical relations between thermistor chain data and geographic location, depth of water, tide, currents, upwelling, island wakes, water masses, storms, season and biological data; conduct deep sea expeditions and joint investigations with other nations and activities.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0144, SEAWATER/SEDIMENT/BIOLOGY MONITORING PROGRAM

W.A. ANIKOUCHINE, Oceanographic Services Inc. , *Santa Barbara, California* 93105

00NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Continental Oil Company

1.0145, DETERMINATION OF EQUATION OF STATE, VISCOSITY AND COMPRESSIBILITY OF SEA WATER

W. DROSTHANSEN, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124 (NONR)

Objective: A fundamental understanding of the physical chemistry of sea water and its physical properties is necessary to support the development and use of oceanographic instruments in Navy surveys, in more accurately determining ocean current structure from mass distributions, in understanding acoustic propagation influencing detection and communication systems, and operating machinery and equipment in naval underwater facilities. The aim of this research is to develop an accurate equation of state for sea water and obtain a better understanding of the structure of sea water mixtures.

Approach: The viscosity and isothermal compressibility of sea water are being measured as functions of temperature and salinity. Laboratory experiments are being conducted covering a range of temperature from O to 40 degrees centigrade; salinity from O to 40 parts per thousand; and pressure from One to 50 atmospheres. Artificial sea water of varied salinity is being investigated first, followed by actual sea water samples from a variety of geographic regions.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0146, SHALLOW WATER OCEANOGRAPHY (SEALAB III)

G.B. DOWLING, U.S. Navy, Mine Defense Laboratory, *Panama City, Florida* 32401

Objective: To determine those environmental factors affecting undersea uses of the ocean. Investigate shallow water parameters affecting MAN-IN-THE-SEA including SEALAB support.

Approach: Conduct physical oceanographic experiments while an inhabitant of SEALAB III. Emphasis is placed on use of instrumentation and the recording of useful quantitative data utilizing the judgment and flexibility provided by an in-situ scientist.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0147, HYDROGRAPHY OF APPALACHEE BAY

K. WARSH, Florida State University, Graduate School, *Tallahassee, Florida* 32306

Measurement of the physical environment of the Florida State University Marine Laboratory on Appalachee Bay. Monitoring of currents and salinity and temperature changes in the bay, winds, rainfall, tides, and solar radiation.

SUPPORTED BY Florida State University

1.0148, INVESTIGATE SEASONAL VARIATIONS, SURFACE WATER TYPES, HAWAIIAN AREA (KOKO HEAD)

G.R. SECKEL, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Honolulu, Hawaii* 96812

Theory shows that processes which determine the temperature and salinity, directly affect their rate of change. At any location, the annual variation of these processes, the net heat exchange across the sea surface and processes associated with water motion (advection and diffusion), is characteristic of that location. Hence, at such a location the rate of change of temperature and salinity also varies in a characteristic manner during the year.

A first approximation of the processes which determine the temperature and salinity in the Hawaiian Islands area has been made (Seckel, 1962, Fish. Bul. 193). It is therefore possible to interpret variations in the rate of change of temperature and salinity at Koko Head, Oahu, in terms of changes in the annually repeating processes which are characteristic of Hawaii.

To refine this method, the seasonal variations of water types, defined by temperature and salinity, are monitored on a continuing basis and will be linked with results of project 131.8G, 'Analyze and publish basic data from pilot study (analytic studies).'

On the basis of the first order approximation, temperatures and salinities monitored at Koko Head, Oahu, are used to predict a favorable or unfavorable environment for skipjack fishing in Hawaii.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0149, PHYSICAL PROPERTIES OF SEA WATER AT PRESSURE

E.M. STANLEY, U.S. Navy, Ship Research & Dev. Center, *Annapolis, Maryland*

Objective: To determine those environmental factors affecting undersea uses of the ocean. Investigate pressure effects on the physical properties of sea water for use in design of heat exchangers, submersible motors, speed reducers, and in deep submergence problems.

Approach: Investigate the physical properties of seawater including viscosity and thermal conductivity as affected by pressure. Special equipment and the Laboratory's high pressure facility will be used, for instance a rolling ball viscosimeter has been adapted for operation under pressure pending completion of the high pressure facility.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0150, PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE UPPER CHESAPEAKE BAY

W.N. SHAW, U.S. Dept. of Interior, Biological Laboratory, *Oxford, Maryland*

Physical characteristics (temperature, current speed and direction, tidal fluctuations, exchange rates and volumes) of local waters and in large man-made salt water ponds are being and will be determined. Chemical characteristics (salinity, oxygen, phosphate, nitrate, etc.) of local waters and in artifical ponds are being and will be determined. Chemical and physical factors of bottom sediments in natural waters and in artifical ponds will also be determined. Information provides baselines to evaluate effects of environmental extremes on commercial shellfish in natural waters and in laboratory experiments.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0151, OCEANOGRAPHIC RESEARCH

A.T. JAQUES, U.S. Navy, Ordnance Laboratory, *Silver Spring - White Oak, Maryland*

To study the oceanographic environment and its effects on naval systems.

Assist in adaptation of sonobuoys to the measurement of underwater sound reverberation and backscatter.

Investigate fluctuation of shallow water sound propagation and look for causative factors.

Measure seismic signatures of ships.

Measure pressure background on the bottom in various geographic areas.

Study optical transmission, scattering and background in representative ocean areas down to great depths.

Study effect of ocean currents on submerged bodies.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0152, FORMATION OF ANTARCTIC BOTTOM WATERS

H.M. STOMMEL, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139

Massachusetts Institute of Technology proposes to investigate the temperature, salinity, and dynamics of water, particularly bottom water, in the Weddel Sea Antarctica. Almost all temperature changes in the oceans occured at the air-water boundary. Cold ocean water must form only in the polar regions, as surface waters elsewhere have temperatures above the world oceans' potential temperature of about 3.5 degrees C. The Weddell Sea area has been suggested as a major source of the cold bottom water of the world oceans. MIT, in cooperation with the Institute of Geophysics, University of Bergen, Norway, would emplace four submerge buoys instrumented for measurements of currents and temperatures on the sea bottom during January 1968. Multiple sea-water samplers would also be placed on two of the submerged systems to obtain a series of water samples during the Antarctic winter. The data that would be obtained from successful recovery of these instruments in January 1969 would help to determine when and at what intervals cold bottom water is formed, and at what critical density- temperature-salinity relationships the sinking of surface water is initiated.

No MIT personnel will go to the Weddell Sea. Two Norwegian scientists will be on the U. S. icebreaker Glacier.

SUPPORTED BY U.S. National Science Foundation

1.0153, PROPERTIES OF SEA WATER

A.L. BRADSHAW, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

Work under this task is being directed towards more accurate determination of the basic physical properties of sea water, thermal expansion and volume conpressibility. This work is in part intended to support the future development of techniques of field measurements by providing accurate and complete measurements of basic properties. A device to measure the microstructure of conductivity and temperature in the ocean is being developed.

More precise knowledge of these physical parameters in the ocean are vital to several Naval activities including large scale surveys.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0154, GREAT LAKES RESEARCH - CHARACTERISTICS OF LAKE WATER

A.P. PINSAK, U.S. Army, Lake Survey, *Detroit, Michigan* 48226

The research involves collection, analysis, and interpretation of data pertaining or related to physical and chemical characteristics of the fresh water in the Great Lakes, including radiological contamination and sound propagation; definition of those water properties which may be utilized as indices of water characteristics and quality; and installation of permanent automatic monitor stations. The broad objectives are to investigate short term variations in water quality and properties, including the factors causing these variations, and to determine and monitor the long term trends. Energy budgets and chemical budgets will be developed to explain evaporation, lake currents and other physical variables.

1. PROPERTIES OF WATER

Systematic collection of data on physical and chemical water characteristics, bottom sediments, meteorological parameters, and wave observations was performed during summer and fall 1965 in Lake Erie and in Lake Huron during the open water season 1966. A similar program will be carried out in the eastern basin of Lake Superior during the 1968 open water season. Reduction, analysis and publication of data from Lakes Erie and Huron is in progress.

SUPPORTED BY U.S. Dept. of Defense - Army

1.0155, (A) ANNUAL SUPPLY OF PARTICULATE MATTER IN THE GREAT BAY ESTUARY (B) LATE PLEISTOCENE HISTORY OF THE GREAT

F.E. ANDERSON, Univ. of New Hampshire, Graduate School, *Durham, New Hampshire* 03824

(A) Sea water samples have been collected on a bi-monthly basis from the Great Bay Estuary since December, 1967. Total particulate matter, particulate carbon, salinity, temperature, and current velocities have been obtained. These data are being related to the factors that affect the particulate matter in estuaries.

(B) Sixty Gravity Cores have been collected from the Great Bay Estuary, New Hampshire and are being processed for texture, composition and Foraminifera. These data, in conjunction with selected C14 dates should enable the investigator to interpret the Pleistocene evolution of the estuarine system.

SUPPORTED BY University of New Hampshire

1.0156, PHYSICAL AND CHEMICAL PROPERTIES OF THE SHELF AND SLOPE WATERS OFF NORTH CAROLINA

U. STEFANSSON, Duke University, Graduate School, *Durham, North Carolina* 27706

This is for the continuation and completion of studies now in progress of the physical and chemical properties of the waters on the continental shelf and in the slope region off North Carolina. The continuing research includes: (1) examination of the acquired data in relation to meteorological factors and processes affecting the renewal of the shelf waters, (2) study of biochemical relationships in Gulf Stream waters and deep and bottom waters of the Hatteras Basin, and (3) investigations of organic and particulate phosphorus and particulate aluminum and iron in the shelf area for studying the distribution of runoff water.

SUPPORTED BY U.S. National Science Foundation

1.0157, PHYSIOCHEMICAL AND ACOUSTIC PROPERTIES OF SEA WATER

D.N. CONNORS, U.S. Navy, Underwater Weap. Res. & Eng. , *Newport, Rhode Island* 02844

Technical Objective: (1) Determination of the heat of mixing in sea water between minus 2 degrees C and 25 to 30 C and estimate its effect on thermal structure of upper layers of the ocean. (2) Develop techniques and instrumentation for measuring partial conductance of salts in sea water and another comparable solution. (3) Measurement of the partial conductances of sodium and potassium chlorides and sulphates and salts of the divalent cation magnesium and calcium in sea water and comparable solution, as a function of pressure and temperature. (4) Estimate specific and nonspecific interactions of the above salts and their effect on velocity of sound in sea water as a function of pressure and temperature. (5) Determination of in situ density anomaly from conductance measurments for nonconstancy of composition in sea water.

Approach: Measurements will be conducted on the heat of mixing at approximately 0 degrees C, as a function of concentration, and on two selected concentrations, measurements of heat of mixing from approximately 0 degrees C to 25-30 degrees C. Evaluations will be made of several high pressure set-ups. Preliminary work will be done on the design and fabrication conductance cells.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0158, BIOLOGICAL AND CHEMICAL STUDY OF VIRGINIA'S ESTUARIES

M.L. BREHMER, Virginia Inst. of Marine Sci. , *Gloucester, Virginia*

Virginia's three major estuarine systems--the James, the York, and the Rappahannock--exhibit different biological characteristics both within and between years. These differences have been noted in phytoplankton populations; in shellfish reproduction, growth, and condition; and in finfish populations.

This study will compare the biological, chemical, and physical characteristics of the three systems. Stations will be occupied at 5% intervals from 25 to less than 0.5% in each river at slack before flood tide. Water samples will be collected at 2 m intervals from surface to bottom and the water column described by temperature, salinity, dissolved oxygen, pH, alkalinity, chlorophyll, suspended solids (loss on ignition and fixed residue), transparency, phosphorus (soluble reactive, soluble unreactive, particulate reactive, and particulate unreactive), and nitrogen (soluble organic, ammonia, nitrite, nitrate, and particulate organic). Primary productivity levels will be determined.

Nutrient levels and turn-over rates, phytoplankton standing crop and productivity, and the dependent and independent physical and chemical characteristics of the three systems will be compared. Data collected by the shellfish and finfish departments at the Institute will be utilized to complete the analyses.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
Virginia Institute of Marine Science

1.0159, INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION SUBARTIC OCEANOGRAPHY

F. FAVORITE, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

Oceanographic measurements of temperature and salinity versus depth and ocean currents are made in the subarctic region of the North Pacific Ocean from the BCF research vessels George B. Kelez and Miller Freeman. Interrelationships among the physical water properties, ocean currents, and sockeye salmon distribution are investigated and reported to the International North Pacific Fisheries Commission. Local coastal areas are surveyed to establish criterion that will permit prediction of environmental conditions. Participation in cooperative oceanographic surveys is scheduled with other BCF laboratories, universitites, and national and international agencies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0160, PHYSICAL OCEANOGRAPHY

W.B. MCALISTER, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

Work in physical oceanography consists of two subprojects: I. Physical and mathematical models of the oceanic processes in the North Pacific Ocean are constructed and examined to obtain insight into the dynamic response of the ocean to the forces acting upon it. Both long term response, and short term departures from average conditions are examined. II. Instrumented field observations and model tests are designed and performed. This has included design and operation of buoy platforms instrumented with oceanographic sensors, telemetry and data recovery and data logging systems including satellite positioning and satellite data relay.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0161, OCEANOGRAPHIC RESEARCH

T. EWART, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

Objective: Provide essential data for design and development of Naval systems and develop techniques for optimum performance and effectiveness of such systems. Investigate the horizontal variations of oceanographic parameters, with particular emphasis on temperature, as related to the ocean's acoustic properties. Relate these variations to gross environmental features which Navy presently has some capability for predicting in an effort to extend the prediction capability.

Approach: Primary data source is the Self-Propelled Underwater Research Vehicle (SPURV) which is a torpedo-like instrument carrier capable of extended cruising at any depth between surface and 12,000 feet. The sensing systems provide for measurement of temperature, sound velocity, pressure, conductivity, and turbulence. Supplemental vertical oceanographic measurements are also made. Understand the basic oceanographic processes which determine the character of the horizontal temperature spectrum and the relationship to acoustic propagation.

SUPPORTED BY U.S. Dept. of Defense - Navy

1E. OPTICAL PROPERTIES

1.0162, MID-DEPTH BIOLUMINESCENCE

B. BODEN, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

Bioluminescence at sea has been studied for many years, but no standardized, quantitative methodology had been developed until very recently. This investigator is utilizing the new approach which involves the simultaneous use of two photometers and which operates with a minimum of disturbance to the organisms. He observes and measures the characteristic patterns of the natural flashing and determines the relationship of these patterns to the environmental conditions under which light is produced. He will also continue his studies of the physiological mechanisms in crustaceans and other luminescing forms which produce and receive light.

This research will contribute to our knowledge of the oceanic environment and will relate especially to the causes and mechanisms of the distribution of light production in the sea, particularly among the populations which make diurnal vertical migrations.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0163, OPTICAL OCEANOGRAPHY IN FLORIDA BAY, FLORIDA STRAITS AND BAHAMA BANK

A. IVANOFF, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

This research concerns thhe study of oceanographic phenomena through the application of optical methods.

The first objective is a study of the relationship between the particle load of a water mass in shallow water and the dynamics of wind-stirred waters. The total surface of particles and their size of distribution will be determined by light-scattering methods. The areas of research for this objective will be west of Abaco Island and in Biscayne Bay.

The second objective is a study of the sediment transport from these shallow-water areas to the deeper oceanic area. Long time series will be necessary. However, knowledge of an established relationship in a well-studied area will make it possible to estimate the year-round transport on the basis of wind observation alone. The research will be carried out at Bear Cut and in the area between Bimini and Cat Cay.

The third objective is the study of the mixing of Biscayne Bay water with the Florida Current. The attenuance meter will be utilized to demonstrate the difference of absorption of coastal waters and oceanic waters. In the course of these studies the 'black screen' attenuance meter will be refined by using photomultipliers.

SUPPORTED BY U.S. National Science Foundation

1.0164, MECHANISM STUDIES ON BIOLUMENESCENT REACTIONS WITH EMPHASIS ON ENERGY TRANSFER PROBLEMS

M.J. CORMIER, Univ. of Georgia, Graduate School, *Athens, Georgia* 30602 (AT(40-1)741)

The mechanism by which chemical energy is converted to light energy is being investigated in several in vitro bioluminescent systems. These include luminous bacteria, sea pansies (Renilla), luminous earthworms, and luminous marine fish. Attempts are being made to isolate the enzymes (luciferase) involved so that their properties may be studied. In addition, attempts to determine the structures of certain of the substrates (luciferin) are being made. Where this has been done we find that the luciferins of marine bioluminescent forms are derivatives of indole. Furthermore, a model bioluminescent system is being studied consisting of horseradish peroxidase, luminol and H202. In this case we have found that luminol radicals and H202 (or a derivative of it) are substrates for the light reaction.

SUPPORTED BY U.S. Atomic Energy Commission

1.0165, BIOLUMINESCENCE

W.D. MCELROY, Johns Hopkins University, Graduate School, *Baltimore, Maryland* 21218

A thorough ecological study of a small phosphorescent bay in Jamaica is being conducted with emphasis on the influence of environmental factors on the physiology, especially photosynthesis and luminescence of the phytoplankton. The bay chsoen is in almost constant bloom and provides opportunity for continuous monitoring of temperature salinity, tide, fresh water influx, and flusing rates, as well as chemical parameters for experimental purposes.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0166, SEA WATER OPTICS STUDIES

J. WILLIAMS, Johns Hopkins University, Graduate School, *Baltimore, Maryland* 21218 (NONR)

The goal is to develop relationships whereby the significant optical properties of sea water could be computed from knowledge of the concentration size distribution and physical character of the suspended matter and vice versa. During the coming year the results to date will be summarized and reported and this task terminated.

Further knowledge of specific optical properties of sea water is required for design improvements of systems which require visibility underwater. The techniques for utilizing optical methods that may evolve from this task should aid in determining optical and particulate characteristics of estuarine environments.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0167, OCEANOGRAPHIC RESEARCH

D.E. MATLACK, U.S. Navy, Ordnance Laboratory, *Silver Spring — White Oak, Maryland*

Objective: Measure optical properties of deep ocean.

Approach: Utilize self-contained submersible cable suspended instrument package to measure spectral absorption, scatter and background visible light for all depths at specific ocean sites. Utilize results to predict utility of optical techniques.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0168, LIGHT IN THE SEA

H.G. HOUGHTON, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139 (NONR)

This project is directed towards developing techniques for the detection, counting and sizing of oceanic particulates through the measurement of the light scattering by the particulates. It may also be possible to deduce the degree of sphericity of the particles through estimation of their optical index of refraction. Both laboratory and field studies are planned. Observations will be made on the optical transmission of light through the water at various wave lengths. Also to be examined are the polarization and angular distribution of the light scattering.

Potential applications of the results of this study are (1) the use of properties of the scatterers as tracers of water motion, (2) predictions of the distribution of solar or artificial light in the sea, (3) possible chemical and biological implications.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0169, FACTORS INFLUENCING THE INTENSITY OF BIOLUMINESCENCE

F.H. JOHNSON, Princeton University, Graduate School, *Princeton, New Jersey* 08540 (NONR)

1. PROPERTIES OF WATER

The investigator is analyzing the chemical and physical factors influencing or controlling the brightness of biologically produced light by two interrelated approaches; the analysis of variations in light intensity under the influence of temperature, hydrostatic pressure, chemical inhibitory or activating substances, concentration of essential reactants, etc., and the isolation and determination of the properties, the reactants of the biological systems for interpretation in kinetic studies.

Bioluminescence is important in operations where visual search or concealment are critical factors. The light producing action of many organisms serves also as a means for quantitative detection of certain trace elements required for luminescence in some forms.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0170, OPTICAL MEASUREMENTS

W.M. EWING, Columbia University, Graduate School, *Palisades, New York* 10964 (N00014-67-A0108-0004)

The objectives of this program are: (1) to study, by means of bottom photographs, the biological and physical properties of and processes which occur at the ocean bottom; (2) to investigate the light scattering properties in the ocean; and (3) to make bottom current measurements. A multipurpose instrument package will replace individual instruments if tests presently underway are successful. This package will provide bottom photographs, bottom current information, water and sediment temperatures, light transmission and light scattering data at up to 20 separate locations on a single lowering.

Naval operations can be made more effective as the nature of the water-sediment interface at the ocean bottom is understood. In support of the need for such knowledge, this program will provide information on the benthos, texture, and strength of the ocean-bottom and on the currents and light-transmissivity in the waters just above the ocean bottom.

SUPPORTED BY U.S. Dept. of Defense - Navy

1F. PRESSURE-DENSITY

1.0171, STUDY OF STABILITY AND SHEAR IN THE TOP 500 METERS OF THE OCEAN

W.S. WOOSTER, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The purpose of this study is to measure and describe the dynamic stability in the upper 500 meters of the ocean at several locations in the California Current. The measurement program is to be carried out by use of a continuous recording in-situ salinometer (STD) and a set of current sensors. The STD records permit calculation of the density profile as a continuous function of depth, while the current sensors determine the vertical shear of velocity. The combination of these two measurements will determine the dynamic stability and permit a quantitative description of the flow regime in and immediately adjacent to the thermocline. This description will be of value in assessing vertical energy transport, leading to a better understanding of the mixing and diffusion processes in the vicinity of the thermocline.

SUPPORTED BY U.S. National Science Foundation

1.0172, SHALLOW WATER OCEANOGRAPHY

G.B. AUSTIN, U.S. Navy, Mine Defense Laboratory, *Panama City, Florida* 32401

Objective: To determine those environmental factors affecting undersea uses of the ocean. To relate ocean wave power and directional spectra in the near-shore to causative factors, and formulate means of predicting environmentally caused pressure fluctuations.

Approach: Investigate pressure spectra using in-situ measurements on the ocean bottom and tanks. Investigate waves by means of sensors at two offshore platforms near Panama City, Florida, measuring simultaneously the time-space variation in surface wave and bottom pressure and extracting such information as (1) directional spectra, (2) low frequency coherent line spectra, and (3) the effects of fetch on the sea spectrum within a well-defined continental shelf area. Use and extend techniques for investigating the oceans' wave spectra at low frequencies. Investigate the environment selectively in time and in space.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0173, OCEAN PRESSURE RESEARCH

W.P. CHRISTOPH, U.S. Navy, Ordnance Laboratory, *Silver Spring - White Oak, Maryland*

Gather and analyze oceanographic data in connection with pressure sensitive equipment.

Record pressure background data at selected places in the Atlantic and Pacific Oceans. Analyse the data such that results are applicable to equipment placed in the sea. Selected locations: Frying Pan Shoal, N.C.; Buzzard Bay, Mass.; Argus Island, Bermuda; off Vancouver Island, Canada (oil drilling rig).

SUPPORTED BY U.S. Dept. of Defense - Navy

1G. THERMAL PROPERTIES

1.0174, THERMAL WAKE STUDIES

E.F. FLINT, North Amer. Rockwell Corp., *Anaheim, California*

Objective: Investigate the thermal discontinuities associated with internal waves and turbulent wakes of submerged bodies.

Approach: Utilize and advanced underwater research instrument previously developed under this effort to measure and analyze the frequency, amplitude, persistence and statistical properties of thermal discontinuities in the ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0175, PACIFIC COASTAL ENVIRONMENT AS RELATED TO DISTRIBUTION AND ABUNDANCE OF GAME SPECIES -- SEA SURFACE TEMPERATURE MEASUREMENTS

G.B. TALBOT, U.S. Dept. of Interior, Tiburon Marine Lab., *Belvedere - Tiburon, California* 94920

Objective: To determine the sea surface temperature gradients in selected areas of the eastern Pacific Continental Shelf. Survey to be conducted in cooperation with the United States Coast Guard, using an airborne infrared radiometer to provide a near instantaneous isotherm picture of the coastal sea surface temperature structure.

To develop detailed synoptic information on one important physical parameter of the marine environment for correlation with available marine fish catch/effort information.

Procedure: Three sectors of the eastern Pacific Continental Shelf covering the areas from Cape Flattery, Wash., to Tillamook Head, Ore.; Pt. Arena to Pt. Sur, California; and Pt. Conception to San Diego, California, with an infrared radiometer mounted in a U.S. Coast Guard aircraft. Sectors to be surveyed monthly with tracks of 700 to 900 nautical miles in length. Sea surface temperature data will be published immediately after each survey in the form of isotherm charts. Observers will also note and record air temperature, visual changes in water color, the extent and direction of convergence lines, location and observed abundance of marine life (fish and mammals). Survey to be conducted once each month for an indefinite period.

In FY 1963 experiments were conducted with an airborne infrared radiometer on accuracy and repeatability. Airborne water temperature surveys were made of coastal inshore area from Mexico to Cape Flattery.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0176, MONITORING SURVEY AND TIME-SERIES ANALYSIS OF SUBSURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN

J.F. SAUR, U.S. Dept. of Interior, Biological Laboratory, *Palo Alto - Stanford, California*

Understanding and prediction of the effects of environmental conditions on the abundance and distribution of fish requires knowledge of the distribution of properties beneath, as well as at, the water surface and the processes by which changes in these properties occur. A glaring obstacle in such research is that subsurface data having both time and space continuity are practically non-existent.

It is impractical because of time, cost, and number of ships required to attempt to obtain such data with oceanographic research and survey vessels. However, the use of expendable instrument systems aboard ships of opportunity, that is, merchant and other ships whose operating costs are already covered, offers the possibility of obtaining highly useful data at a reasonable cost. Use of this method should be begun as soon as possible.

There is no precedent for collecting the subsurface temperature data on a time-series basis as proposed here. The specific data to be collected are needed for research by the BCF Biological Laboratory, Stanford. It is equally important, however, that the feasibility of collecting such data from ships of opportunity be demonstrated and a particular system be tested on an operational basis with the data also feeding into the Navy operational forecasting system.

The objectives are to determine quantitatively the variations in thermal structure of the upper layers of the water column and their relation to other oceanographic conditions, such as currents, and to the local energy exchange at the sea surface; and at the same time to pioneer a joint BCF-Navy effort for producing mutually needed ocean information. The initial step in this is to establish a pilot study for the collection of time-series subsurface temperature data using ships of opportunity. Such a pilot project was started in June 1966 aboard the Matson Navigation Co. ship SS CALIFORNIAN. Temperature observations to 1500 ft. depth and at spacing of 100 naut. miles are being obtained about twice a month from Honolulu to San FRancisco.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0177, THERMAL PROPERTIES OF SEA WATER AT LOW TEMPERATURE AND HIGH PRESSURE

D.R. CALDWELL, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (NONR)

The objective of this task is to obtain precise measurements of the coefficient of thermal expansion, the specific heat, and the thermal conductivity of sea water at low temperature and high pressure, such as occur in deep water and to apply these to investigation of processes affecting heat and mass exchanges in the water layers close to the sea floor. Both laboratory and field measurements are being made. Measurements of water flow at the bottom involve heated thermistor anemometers mounted on the Snodgrass-Munk deep sea tide recorders.

There is a recognized need for better fundamental values of the physical and chemical properties of sea water. Such information will contribute to the accurate determination of the speed of sound in deep water. It will also provide basic engineering knowledge to support naval systems operating at great depths or on the sea floor.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0178, BATHYTHERMOGRAPH ANALYSIS

M.K. ROBINSON, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038 (NONR)

The objective of this task is to provide descriptions and models of the surface and near-surface temperature structure of the oceans as derived from the analysis of bathythermograms achieved at Scripps, Woods Hole and the National Oceanographic Data Center. Objective analytical techniques have been developed and the results of analyses of data from the Pacific, Atlantic and Indian Ocean are being prepared for publication in atlas format by the U. S. Naval Oceanographic Office. A preliminary analysis of Indian Ocean hydrographic stations and BT data is being prepared for publication and analyses of the salinity structure of the upper layers of the oceans is to be undertaken based upon hydrographic station data.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0179, HISTORICAL CHARTS AND INTERPRETATION OF CHANGES IN SEA SURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN

L.E. EBER, U.S. Dept. of Interior, Ocean Research Lab. , *Stanford, California*

Sea surface temperatures (Intake or injection temperature observations taken by surface ships) provide the only ocean-wide data with satisfactory long-term continuity from which to infer historical changes that have taken place in the circulation of the ocean. The construction of monthly sea surface temperature (SST) charts is thus a necessary step towards understanding the interrelationship between atmospheric and oceanographic environments and their effects upon commercial fisheries, following which the changes in SST between different years can be analyzed with relation to changes in other environmental conditions.

The objective is to provide basic data for research on changes in oceanographic conditions by developing and publishing an atlas of mean sea surface temperature for the North Pacific Ocean and of anomalies from a suitable mean period, month by month for the period 1949-1962, during which suitable data are known to exist. The year 1956 and 1957 were selected for initial study. Data for each of the 24 months were plotted and analyzed, and the resulting set of charts were published in the spring of 1962. It was determined that the preparation of charts for additional years would be accomplished more quickly and with improved quality, by switching from manual to machine processing of the data. This change made feasible the inclusion of refined editing procedures too lengthy to carry out by hand. The entire program involves several stages, ending with machine analysis and charting, using programs developed at the U.S. Navy Fleet Numerical Weather Facility, Monterey.

Publication of the 14-year series of charts is expected by the summer of 1968. Continuing work includes the preparation of monthly normal charts based on the 14-year period of reference and of anomaly charts for each month of each year. Charts depicting within-month and year-to-year variation also will be prepared.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0180, EVALUATION OF LOW LEVEL TEMPERATURE GRADIENTS OVER THE LINE ISLANDS NEAR THE EQUATOR

W.M. GRAY, Colorado State University, Graduate School, *Fort Collins, Colorado* 80521

The purpose of this proposed work is to study the sea-surface and sub-cloud layer temperature gradients in the vicinity of the intertropical zone during the Line Island Experiment in early 1967.

Measurements will be made using two radiometers mounted on the Woods Hole Oceanographic Institution's C-54Q aircraft. An aerosol counter will be placed on the aircraft also to help determine the effect of a hazy environment on the radiometric measurements. The sea surface temperature will be mapped in the vicinity of the Line Islands. Values will be checked with other measurements made by other groups and using different techniques. It is hoped to correlate the measurements with other available synoptic and meso-scale observations to help determine the cause of observed satellite 'cloud blobs'.

SUPPORTED BY U.S. National Science Foundation

1.0181, MILLSTONE POINT TEMPERATURE SURVEY

W. OWEN, Raytheon Company, *New London, Connecticut*

A 12 hour temperature and salinity survey was conducted at Millstone Point, Connecticut to document the vertical distribution of temperature and salinity at each of three stations before the world's largest atomic power plant goes into operation next year.

A similar survey will again be conducted in March 1969.

SUPPORTED BY North East Utilities Service Company

1.0182, MONTVILLE STATION TEMPERATURE SURVEY (THAMES RIVER)

W. OWEN, Raytheon Company, *New London, Connecticut*

1. PROPERTIES OF WATER

The non-consumptive use of water for cooling the condensors of thermal power stations requires a knowledge of the distribution of temperature in the body of water used for the purpose.

In August, September, and November of 1968, MRL conducted a temperature survey of the Thames River Estuary in the vicinity of an operating thermal power plant. An average of 130 continuous temperature profiles were made over a 12 hour period on each of the eight survey days. In addition, meteorological measurements, tide measurements, salinity determinations, and bathymetric measurements were made.

The data from the survey was presented to the funding agency in the form of 184 cross section contour maps and 30 planner contour maps of the temperature data.

SUPPORTED BY Bechtel Corporation

1.0183, THE CONTRIBUTION OF ADVECTION AND LOCAL HEATING TO THE MAINTENANCE OF THE THERMAL STRUCTURE IN THE NORTH PACIFIC OCEAN

K. WYRTKI, Univ. of Hawaii, Graduate School, *Honolulu, Hawaii* 96822

The thermal structure and the distribution of sea surface temperature within the mixed surface layer is maintained by the combined action of heat exchange at the sea surface and of ocean circulation. The heat exchange changes the temperature locally, while the circulation by the processes of advection and mixing redistributes the heat. Since 1948, monthly charts of sea surface temperature and of the anomaly of sea surface temperature from the long-term mean have been published for the North Pacific Ocean, but the interpretation of the origin, redistribution and of the decay of such temperatures anomalies has not advanced beyond speculations.

Under this grant, investigations will be made on the interaction between the field of heat exchange, circulation and temperature distribution, to establish firm quantitative relations between these fields, which are suitable for the calculation of the behavior of anomalies of these fields, and to compare such results with actual observed situations.

SUPPORTED BY U.S. National Science Foundation

1.0184, THERMAL STRUCTURE

E. SCHROEDER, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-CO-241)

This program calls for the systematic collection of data from an oceanographic station off Bermuda that has been occupied approximately fortnightly since 1954 and for the analysis of the time series in terms of fluctuations in temperature, salinity and steric sea level. Analysis of North Atlantic thermal data is a continuing program. An atlas of smoothed average temperatures at five levels is being prepared in cooperation with NavOceanO and Scripps.

The results from this task should provide a better understanding of long-term changes in the ocean to assist in the planning of Naval operations and in the development of design criteria. Work from this task has contributed to the program at the Naval Numerical Weather Facility, Monterey.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0185, GREAT LAKES RESEARCH - MONITORING OF WATER CHARACTERISTICS

A.P. PINSAK, U.S. Army, Lake Survey, *Detroit, Michigan* 48226

A system of permanent automatic monitor stations will be developed to continuously measure and record geophysical processes that affect or are influenced by the Great Lakes and their environment and to program observations for timely use in forecasts and control. As a first phase in this program continuous automatic water temperature recorders have been installed at 10 sites along the periphery of the U. S. portion of the Great Lakes. These stations will be removed as the comprehensive monitoring program develops.

Hourly water temperatures, daily and monthly mean temperatures at each of the ten sites are published regularly.

SUPPORTED BY U.S. Dept. of Defense - Army

1.0186, CALORIC - AN INVESTIGATION OF HEAT RELEASE PATTERNS ASSOCIATED WITH PRESENT AND PLANNED LAKESHORE ELECTRICAL POWER PLANTS

G.J. NEUMAIER, Cornell Aeronautical Lab. Inc. , *Buffalo, New York* 14221

The objective of this program is to investigate the thermal pattern in the vicinity of an existing electrical power station and to develop a theoretical model for predicting the thermal pattern that will prevail during the operation of a planned nuclear facility near an existing plant. This program will provide information for assessing the influence of the future thermal discharge from the nuclear plant on lake ecology and for determining the preferred locations of the intake and discharge tunnels of that plant.

The program consists of three tasks: (1) the development of a theoretical model of the lake thermal characteristics, (2) measurement of the lake surface temperature distribution using an airborne infrared radiometer, and (3) the design, fabrication, and installation and routine maintenance of lake temperature and current instrumentation.

SUPPORTED BY United Engineers & Constructors Inc.

1.0187, COLLECTION AND INTERPRETATION OF OCEANIC THERMAL GRADIENTS

M.G. LANGSETH, Columbia University, Graduate School, *New York, New York* 10027

The object of this investigation is to continue regular heat flow measurements from the R/V Vema and R/V Conrad in an attempt to delineate large areas where the heat flow is low, normal, or high. In addition, it is hoped that certain areas such as the East Pacific Rise and the Sigsbee Knolls area of the Gulf of Mexico can be thoroughly investigated with the use of satellite navigation or anchored buoys to determine the nature of large heat flow variations over relatively short distances.

A temperature-measuring instrument, the thermograd, developed at Lamont Geological Observatory, allows the continuous measurement of water temperature from close to the surface to the ocean bottom and also the thermal gradient of the sediment. To date, many hundreds of measurements have been made using this device. Recent results in the East Pacific Ocean show high heat flow over the East Pacific Rise between Panama and Hawaii, low heat flow in the Guatamala Basin, about average heat flow close to Hawaii. Other results in the same area show high heat flow off the coast of Washington State and a surprisingly uniform heat flow south of the Mendocino Fracture Zone in a line between Victoria, British Columbia, and Midway Island.

SUPPORTED BY U.S. National Science Foundation

1.0188, TEMPERATURE MICROSTRUCTURE AT THE OCEAN FLOOR

G. BODVARSSON, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

This is a renewal of GP-4642 to make temperature measurements at the bottom of the ocean in both the water and the bottom sediments for extended periods of time. Two analog recording thermoprobe instruments have been assembled and calibrated. The instrument package has been operated at a depth of 1500-1700 fathoms for a period as long as 22 hours. Techniques have been developed to measure temperature gradients for a period of several weeks, using a buoy. Heat flow measurements have been made in two areas off the coast of Oregon and a number of theoretical studies have been made.

It is proposed to develop the instrument package to arrive at observation periods of three to six months. The data will be studied with regard to the stability of the bottom boundary layer. The importance to the evaluation of existing heat flow measurements at sea are obvious. Theoretical studies will be continued.

SUPPORTED BY U.S. National Science Foundation

1.0189, A STUDY OF THE TEMPERATURE MICROSTRUCTURE AND EDDY TRANSPORT IN THE OCEAN FLOOR BOUNDARY LAYER

G. BODVARSSON, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Under previous NSF support three analog recording thermoprobe instruments have been assembled, calibrated and field tested. Each probe carries eight thermistor sensors and a sediment sampler. The probes furnish data on the temperature up to 3.3 meters above and down to two meters below the ocean floor as well as on the heat flow through the bottom interface. They have operated satisfactorily in 3,000 meters of water for periods up to 22 hours. The temperature measurements can be made with a resolution of plus and minus 0.004 degree centigrade. Two of the probes were lost during field operations, but a fourth one is now being assembled.

A fifth temperature probe for longer period temperature recording is partially finished. This unit has the capability of scanning ten sensors and converting the input to a digital format for storage by a magnetic tape recorder. The total storage capability of the tape unit will extend the in situ recording time to three months.

The objective of the presently proposed research is to make further improvement of the temperature probing equipment and to continue the experimental program on the temperature structure and heat transport in the lowest section of the ocean floor boundary layer.

SUPPORTED BY U.S. National Science Foundation

1.0190, AIRBORNE SEA SURFACE MEASUREMENTS IN THE EQUATORIAL PACIFIC

R.A. RAGOTZKIE, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

The objectives of the proposed research are to map the surface temperature field of the ocean by airborne infrared radiometry and then interpret the results in terms of related atmospheric and oceanic phenomena.

A Barnes (IT-3– infrared radiometer will be mounted in the NCAR aircraft and converted to the ARIS data acquisition system aboard the plane. The radiometer will be used in fixed and tilted modes so both the sea surface temperatures and the amount of water vapor in the atmosphere can be measured.

It is anticipated that the variability in time and space of the sea surface temperature can be documented, that the effect of atolls can be ascertained, currents can be delinated and oceanic fronts observed. All of these observations will be of great use in understanding better the interaction between the ocean surface and the overlying atmosphere.

SUPPORTED BY U.S. National Science Foundation

2. WATER MOTION

(see Also Air-sea Interaction in Chapter 3a and Hydrodynamics, Chapter 8i)

2A. CIRCULATION-CURRENTS

2.0001, RADIOISOTOPE TRACERS IN OCEANOGRAPHIC RESEARCH

E.A. SCHUERT, U.S. Navy, Radiological Defense Lab. , *Hunters Point - San Francisco, California* 94135

Objective: Investigate radioactivity and measure fallout isotopes in the ocean that are useful in tracing vertical migration and circulation of water and concentration of water properties. To establish methodologies for determining the distributions of naturally occurring and man-introduced radioactivity in the oceans and to develop research instrumentation as required.

Approach: Develop in-situ gamma radiation detectors for employment on submersibles and for more general use from surface vessels. Evaluate the capabilities of such detection systems as oceanic radioactivity probes. Map the known present oceanic inventory of fission products, induced radioactivity and special fuels; locate and account for future injections from oceanic, atmospheric, and terrestrial sources; define the trace elements of interest and their physical and chemical states in sea water; define their interactions with the bio-mass; develop isolation techniques for gamma spectrometric measurements of micro trace quantities; initiate a program for sampling the surface waters of the world from ships of opportunity; and schedule specific cruises in the North Pacific Ocean for the determination of vertical profiles. Apply data analysis, with the aid of sophisticated computer programs, to the extension of present theories and the development of new theories on the circulation, mixing and turbulent diffusive processes extant.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0002, OCEAN CIRCULATION

R.S. ARTHUR, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (NONR)

The purpose of this investigation is to advance qualitatively, through the development of analytical and numerical models, an understanding of features of both oceanic and near-shore circulation to the point where circulation behavior can be predicted. Wind-driven circulation near-shore and over submarine canyons is being studied to obtain a model of water and sediment transports in rip currents and in the circulation over canyons. Attention also is being given to the eastern boundary current off California in order to establish a dynamic model for the mean flow in this region and help in planning mesoscale arrays of buoys.

Forecasting the movement of ocean water, or deducing such movements, from available oceanographic and meteorological observations depends on adequate theoretical understanding of the processes and dynamics of oceanic systems. This work is making substantial improvements in such theory.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0003, STUDY OF OCEAN CURRENTS AT SEA FLOOR AND THEIR SPACTIAL CORRELATION

C.S. COX, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

A continuing effort is underway to obtain the very long time series of ocean current observations necessary to reliably distinguish between the various possible types of water motion having periods longer than tidal periods. It is not planned to measure currents throughout an entire water column, but rather to undertake a variety of measurements using instruments which rest solidly on the sea floor.

The first set of measurements involves operating current meter stations on the sea floor for extended periods of time. The current meters, commercially available, are mounted rigidly in a tripod so as to record at about one meter above sea floor and are recoverable by means of a line attached to a surface float. The meter-buoy station may be left unattended for about six weeks, after which the current meter is retrieved, serviced, and replaced on the bottom.

In conjunction with the current meter observations, measurements of the electric field at the bottom of the sea will be attempted. The measurements of electric field will permit estimation of the barotropic component of water flow. This will complement the bottom current measurements which, of course, make no distinction between barotropic and baroclinic components of the flow.

SUPPORTED BY U.S. National Science Foundation

2.0004, BOTTOM CURRENTS AND DEEP SEA TIDES

M.C. HENDERSHOTT, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (NONR)

The purpose of this task is to develop an understanding of long period waves and currents in the ocean, including tides, through theoretical and observational investigations. The theoretical work consists of devising computational methods capable of representing long period gravity and planetary wave oscillations in deep basins. Observational work consists of measurements of water flow in deep water within a few meters of the bottom where the effects of friction are evident. During the coming year, it is proposed to use finite difference calculations for solving the deep-sea tide problem, on a model which has boundary conditions simulating the effects of energy dissipation and trapping near coasts. Current meters are to be developed to measure the directional components of current velocity in the boundary layer immediately above the ocean floor in the deep sea.

2. WATER MOTION

The Navy is embarked on a deep ocean technology program designed to improve man's capability to work and install equipment on the ocean floor. In addition, sound propagation is affected by physical variations in the deep ocean waters. This task will provide knowledge of the variations and causes of such variations pertinent to these Navy problems.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0005, A STUDY OF THE DEEP CIRCULATION AND DEEP FISH POPULATIONS IN THE PACIFIC OCEAN

J.D. ISAACS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (AT(11-1)34-127)

Until this last year the deep currents in the oceans have been only rarely measured, although many aspects of the circulation have been theorized from models and from the evidences of various physical and chemical variables such as temperature, salinity, oxygen, carbon 14, etc. During the last year 15 direct current records (3 meters off the bottom) have been obtained at about 4 km in depth, 400-800 km off the West Coast of northern Baja California, Mexico. The direct measurements in this area show a coherent net transport of about 2.2 cm per sec in a southeasterly direction; a semidiurnal fluctuation of an rms amplitude of about 1.7 per cm. per sec., rotating counterclockwise; and with the phase coherent with the dominant component (the semi-diurnal lunar component) of the tides at La Jolla, California. This extent of coherency greatly increases the possible significance of widely-spaced observations, and it now appears that such measurements can be highly significant in elucidating the deep circulation and tides over the entire basin.

The plan is to conduct a widespread study of deep currents and related factors in the Pacific Ocean during the next year for the purpose of elucidating the nature of the deep circulation and the fluctuating currents.

In one year we will not have gathered a large number of deep measurements but we will have measurements broadly spread in the Pacific Ocean. This information should yield great insight into the nature of the deep currents, and permit the design of an optimum study of currents in the entire basin.

Other measurements that are planned at some current stations are free vehicles with a camera and a fish trap; temperature and salinity to the bottom; and opening and closing net tows in the deeper layers.

SUPPORTED BY U.S. Atomic Energy Commission

2.0006, STUDY OF DEEP PACIFIC CIRCULATION USING SILICON-32

H.W. MENARD, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The research program proposal aims towards an understanding of the nature of circulation in the deep Pacific Ocean using cosmic ray produced Si 32 as a tracer. Whereas several radioactive techniques have recently been employed to investigate the characteristics of circulation of water in the oceans, they are at best primarily suited for evaluating the gross features of circulation, viz., the turnover time of oceans. Extensive studies of cosmic ray produced C 14 in sea water and of another cosmic ray produced radioisotope, Si 32, in surface marine waters have provided useful information in this direction. The available measurements on the specific activity of C 14 in the bicarbonate of deep Pacific waters show that the horizontal and vertical gradients that exist in its specific concentration are often small compared to the precision of measurement and, furthermore, close in magnitude to the effect produced by the dissolution of gravitationally settling skeletons which results in a direct in situ addition of carbon of higher specific activity. In view of the above, the C14 data lead only to a box-model type analysis with most of the deep oceans being considered as a well mixed reservoir.

SUPPORTED BY U.S. National Science Foundation

2.0007, CIRCULATION OF THE PACIFIC

J.L. REID, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038 (NONR)

The objective is to chart and understand the overall large scale circulation of the northwest Pacific and the origin of the deep waters of the major ocean basins. The approach is to examine along with other physical and chemical properties potential density as an indicator of flow, and to measure bottom currents at great depths. During the coming year, data from 10,000 deep water stations spread over the world ocean are to be analyzed. Bottom current meter observations are to be made around the Central Pacific Basin to obtain details of the water exchange between the North and South Pacific.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0008, NATURE AND VELOCITY OF CURRENTS AND OTHER FLOWS IN SUBMARINE CANYONS

F.P. SHEPARD, Univ. of California, Graduate School, *San Diego — La Jolla, California* 92038

Thorough study will be made of the various currents and sediment flows in submarine canyons where they are particularly amenable to study since the location is predictable. Working together with scientists of the Navy Electronics Laboratory, San Diego, and the local branch of the U. S. Geological Survey, extensive current meter studies in the canyons near Scripps Institution are planned. This would be supplemented by the planting of event recording devices within the canyons, which would be released and rise to the surface after a strong flow down the canyon floors, and would provide us records of the transient flow velocities. In addition, attempts would be made to set off flows in the canyons with the help of the best available information on soil mechanics. The movement of traceable sands and other recognizable objects down the canyon floors would be followed. The work would also involve supplementary studies of upwelling, downwelling, and the sedimentation taking place in the canyon heads. This work would be coordinated with observational studies made by scuba divers and deep diving vehciles presently studying the canyons.

The investigation should provide much needed information on the true nature of turbidity currents, and also should determine to what extent ordinary currents and powerful flows, other than turbidity currents, are contributing to the phenomena that are generally considered the work of turbidity currents. Information coming from the project should prove valuable, not only in interpreting such features as submarine canyons and great sea fans, but could also provide helpful information for man's rapidly expanding utilization of the sea floor.

SUPPORTED BY U.S. National Science Foundation

2.0009, DESCRIPTIVE OCEANOGRAPHY/PACIFIC

B. TAFT, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (NONR)

The purpose is to understand the air-sea interactions involved in large ocean currents. Attention is being focused on the equatorial system using data collected largely on operation EASTROPAC. Physical data from continuous recording devices and time series from buoys are being examined by computation for information on the interaction between the changing atmospheric circulation and the current system.

The results of the analysis from this work are expected to contribute significantly to the understanding of a major portion of the eastern Pacific Ocean. Such knowledge will be useful for planning of naval operations and furthering our ability to describe and predict large scale changes which the atmosphere may induce in the oceans.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0010, CIRCULATION AROUND OCEANIC ISLANDS

W.G. VANDORN, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

Objective: To study the character and mechanisms of circulation around oceanic islands. Initial emphasis will be given to islands in dynamically stable regions where a deep thermocline and steady trade winds prevail. Such regions comprise most oceanic areas between latitudes 30N-30S, and might be termed 'oceanic deserts,' because vertical mixing is strongly opposed by a stable density structure, and the surface waters are consequently nutritionally impoverished. Except for the equatorial current system, the flow regime in these latitudes consists of the sluggish geostrophic flow of warm surface water under the action of wind stress, with essentially no motion below thermocline depth.

However, the presence of an island obtruding on such a flow regime apparently results in an anomalous circulation strong enough to overcome surface stability and cause mixing with subsurface water, as evidenced by locally nutritionally rich water and the abundance of marine life. Because the thermocline depth is generally below the effective depth of wind-wave action in tropical oceans, other mechanisms must be sought to explain vertical mixing. These include: (1) The formation of vortices and vortex streets as the result of perturbed flow around an island. (2) Upwelling and downwelling as a result of differential wind stress and continuity. (3) Enhancement and breaking of internal waves on equi-potential surfaces where strong density gradients exist. (4) A thermohaline circulation, as the result of anomalies in the evaporation-precipitation balance over an island.

SUPPORTED BY U.S. National Science Foundation

2.0011, CONVECTIVE STUDIES

T.D. FOSTER, Yale University, Graduate School, *New Haven, Connecticut* 06520 (N00014-66-C0171-A01)

The objective of this task is to study the basic aspects of convective processes and their application to oceanographic phenomena. Emphasis is upon the theoretical and experimental study of thermohaline convection induced in the surface layers of the ocean by the evaporation of sea water at the surface. Another theoretical investigation also is attempting to explain the processes which produce the superadiabatic temperature gradients believed to be present in the bottom layers of the deep ocean. Field work at sea on the thermal structure of the mixed surface layer is expected to be carried out from FLIP in the North Pacific Ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0012, DYNAMICAL OCEANOGRAPHY AND GEOPHYSICAL FLUID DYNAMICS

G. VERONIS, Yale University, Graduate School, *New Haven, Connecticut* 06520

Studies will include (1) theoretical studies of thermal convective processes in fluids when a salt gradient can act as a stabilizing agent; (2) theoretical and numerical studies of large-scale ocean circulation generated by horizontal temperature differences and by fluctuating winds at the surface; (3) theoretical investigations into the attenuation of low frequency sound in the ocean; (4) experimental models of processes and phenomena which can be produced in a rotating tank in the laboratory and which are meant to simulate natural phenomena. Continuing on these projects will be George Veronis as principal investigator, and George Buzyna as post doctoral research associate.

SUPPORTED BY U.S. National Science Foundation

2.0013, FLUSHING PATTERN OF CERTAIN TIDAL STREAMS IN DELAWARE

F.C. DAIBER, Univ. of Delaware, Graduate School, *Newark, Delaware* 19711

Our various biological and hydrographic investigations within the tidal creeks adjoining Delaware Bay over the past years point up the need for a more thorough knowledge of the circulation patterns and other hydrographic features within these tidal creeks. This information will identify the location and volume of fresh water during various tidal and seasonal conditions. Such information is of value in selecting sites and times for withdrawal of water for irrigation, farm and industrial usage. It has implications in terms of domestic and industrial pollution and health, transport of plant nutrients from coastal marshes and survival of eggs and larvae of fish and shellfish. This study could serve as a model for study of creeks of other sizes and magnitude of tributaries. This work is to begin in fiscal year 1967 and terminate at the end of fiscal year 1969.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Delaware

2.0014, WESTERN ARCTIC OCEANOGRAPHIC INVESTIGATIONS

R.B. ELDER, U.S. Dept. of Transportation, Oceanographic Unit, *Washington, District of Columbia*

Because of the U. S. Coast Guard's unique capabilities in polar operations, it has a responsibility for conducting and coordinating oceanographic research activities in the Arctic. Present programs conducted by the U. S. Coast Guard Oceanographic Unit include oceanographic studies in the Chukchi, East Siberian and Laptev Seas, the Bering Strait and Bering Sea. Emphasis is on the circulation and interchange of Arctic and North Pacific waters.

Presently this work is being conducted aboard Coast Guard icebreakers during intervals when the vessels are not engaged in their primary mission of the support of shore-based defense and scientific installations.

Also of interest is the study of the oceanography of the Arctic Basin. Studies of areas from which there is little or no oceanographic data are particularly important. Results of these programs are published in the CG-373 Series.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

2.0015, OCEAN CURRENTS AND CIRCULATION

L.A. BANCHERO, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

OBJECTIVES: Develop deep-ocean data collection techniques using moored instrument arrays; study the variability of ocean currents and temperature structure through the employment of these systems. Formulate mathematical prediction models for ocean currents.

APPROACH: The vertical and horizontal variability of kinematic features of the ocean over synoptic (100-1000km) and meso (10-100km) scales and over temporal scales of one month to one season will be studied. The spectral energy content of currents, particularly the relative amplitude of peaks which appear at inertial and tidal frequencies, is expected to yield significant information. The relationship of current measurements to the general ocean circulation at various latitudes must be studied in order to formulate prediction models.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0016, OCEAN CURRENT TRANSPORT

W.S. RICHARDSON, Nova University, Graduate School, *Fort Lauderdale, Florida* (N00014-67-A-0386-0001)

This is a combined field and theoretical study of the structure and variability of ocean currents. Special emphasis is given to measurements of velocity field in vertical cross-sections across the Gulf Stream along the E. Florida coast using freedrop instruments from ships and very accurate, limited-range navigation. Support of this study involves improved instrumentation and associated researches in physical oceanography. The studies of downstream variation in Gulf Stream transport have extended from Miami to Jacksonville; this year will extend these studies to Cape Fear and possibly Cape Hatteras. Emphasis will be placed on study of velocity structure at bottom and lateral boundary layers of Florida Current in Straits of Florida through use of current meter strings. Limited theoretical studies are designed and executed to complement the field program.

The development of navigation and measurement techniques for accurately determining structure of ocean currents is important for a variety of naval problems involving the placement of instrument arrays and structures; economical ship routing; and localized search and survey operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0017, STUDIES OF THE TRANSPORT OF THE FLORIDA CURRENT

W.S. RICHARDSON, Nova University, Graduate School, *Fort Lauderdale, Florida*

The Principal Investigator has recently developed a technique for the rapid measurement of vector transport which permits the measurement of total flow of a large current with good accuracy. The method consists of dropping a free instrument at a known point from which it falls to the bottom, releases weights and returns to the surface under its own buoyancy. The instrument contains internal recording of pressure versus time and is accurately fixed when it surfaces.

This method requires the availability of a precise navigation system. By increasing the transmitted power of the presently available HiFix system, it will be possible to provide navigational accuracy of plus or minus 2 meters throughout the Straits of Florida, Northeast and Northwest Providence Channels and to the North and East of Little Bahama Bank (range of 250 miles). With this increase in coverage it should be possible to determine the transport through the Little Bahama Bank-Palm Beach section and the flow out of Northwest Providence Channel, as well as the transport through the Miami-Bimini section. In this way, the contribution of the channels to the Gulf Stream can be determined.

In all of these sections, the vertical and horizontal distribution of transport will be determined and efforts will be made to compare these with geostrophic determinations made from hydrographic stations. In addition to transport measurements of the above type, current meter installations will be made both at the shorelines and in deep water to determine the shape of the tidal wave in the straits and associated channels.

SUPPORTED BY U.S. National Science Foundation

2.0018, RESIDENCE TIMES OF WATERS BEHIND BARRIER ISLANDS

R.G. DEAN, Univ. of Florida, School of Engineering, *Gainesville, Florida* 32601

The proposed research comprises the development and evaluation of a numerical model to calculate the residence times of the waters in lagoons behind barrier islands and in interconnected bay systems. The numerical model will be based on the governing differential equations of motion and continuity including all nonlinearities. Wind stresses, precipitation and tidal displacements at the openings to the water system under consideration will be included as 'input' to the numerical model. The model 'output' includes predictions of water velocity and elevation as functions of time and position in the water system. The 'output' is generated by representing the water area as a grid system and solving the governing difference equations for the prescribed spatial and temporal distributions of the input functions. To assess the validity of the model, a field program will be conducted to measure the input and output functions for at least two different water systems. The validity and limitations of the model will be based on a comparison of measured water elevations and velocities with those determined from the numerical model.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Florida

2.0019, SEA SURFACE SURVEILLANCE

J.T. BRUCKS, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab., *Miami, Florida*

Objectives: 1. To obtain data concerning the variation of properties of surface water entering the Caribbean Sea to test the relationship of the spatial and temporal distribution of tuna schools to variations in the circulation. 2. To contribute to the understanding of the oceanography of the Caribbean Sea and western tropical Atlantic Ocean. 3. To establish effective sampling procedures to be used at shore stations and on ships of opportunity in this and other areas of investigations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0020, WATER MASS TRACERS

C.H. OPPENHEIMER, Florida State University, Graduate School, *Tallahassee, Florida* 32306

The objective of this task is to determine the role of planktonic Foraminifera as biological tracer organisms in identifying major currents and water mass distribution patterns. Specifically, the research will determine the limits of precision of this method and further develop its application. During the coming year the effort will be devoted primarily to analyzing the several thousand samples which have been collected in the eastern Equatorial Pacific and are being collected in the tropical Atlantic. These analysis will be compared to other physical and chemical measurements.

Sound propagation in the ocean is affected by the density structure as well as water velocity and biological concentrations. The distribution of these properties is dependent upon circulation patterns which are not understood. This task should provide a powerful tool for studies of oceanic circulation.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0021, HAWAIIAN OCEANOGRAPHY

K. WYRTKI, Univ. of Hawaii, Hawaii Inst. of Geophysics, *Honolulu, Hawaii* 96822 (NONR)

The effect of the Hawaiian Islands on the North Equatorial Current is being investigated to determine the influence of an island chain in mid-ocean on the structure and dynamics of a larger permanent ocean current. The investigation is concerned with the study of the North Equatorial Current, its modification during flow through the various channels between the islands and the development of eddies behind the island chain. Particular emphasis is on the formation, the duration and the decay of eddies; the correlation of sea-level differences between islands with the flow through channels and development of eddies; and the tidal current pattern in the Hawaiian Islands region and in the open ocean away from the Islands.

This study should result in information on the disturbance of the oceanic structure in the vicinity of a mid-ocean island chain, on the variations in time and space of the thickness of the mixed surface layer, of the depth and intensity of the thermocline and of the surface and subsurface circulation in channels between the Hawaiian Islands. Since naval operations take place in the vicinity of these islands, the knowledge of these oceanic parameters and their fluctuations are of importance to the Navy.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0022, CIRCULATION IN THE GULF OF MEXICO

K. DRENNAN, Gulf South Research Institute, *Baton Rouge, Louisiana* (N00014-67-C-0514)

The purpose of this investigation is to study the circulation of the northeastern and central portions of the Gulf of Mexico. Emphasis is on the circulation of shelf water in the northeast Gulf, particularly the effects induced by the Mississippi outflow and the Loop Current. Both hydrographic data and airborne IRT observations are being used to determine and elineate flow patterns. The surface circulation features of the Yucatan and Loop Currents in the Central Gulf also are being studied by airborne IRT in an attempt to correlate observed patterns with circulation features derived from standard oceanographic observations.

This task is part of the Navy's broad basic research program in oceanography to provide a better understanding of the Navy's operating environment. Results from this task are expected to contribute to operations by furthering the understanding of the circulation and water structuring of such regions.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0023, THEORETICAL AND LABORATORY MODEL STUDIES OF LARGE-SCALE OCEAN CIRCULATION

A.R. ROBINSON, Harvard University, Graduate School, *Cambridge, Massachusetts* 02138 (N00014-67-A-0298-0011)

Objective: The accomplishment of many operational Navy objectives such as prediction of subsurface currents during deep-sea operations, is contingent upon knowledge of water movements and the associated physical property distributions. In turn, the goal of predicting three-dimensional configurations of ocean currents depends in large measure on improved understanding of the fundamental processes involved. This research is a successful example of the application of basic fluid mechanics to understand motions in the rotating fluid envelope which is the real ocean.

Approach: Experimental and theoretical model studies of the motions, associated forces and energy of fundamental processes in ocean circulation constitute most of the work. Quantitative comparison of theory with the results of experiments performed with a rotating model of a curved sea will continue to provide critical tests for many aspects of the general ocean circulation. Numerical modeling of time-dependent, intense, jet-like currents will continue. A predictive model of the variation in Gulf Stream path will be tested by a field experiment during summer of 1969. The study of processes involved in the subsurface equatorial current system and in the large-scale interaction between ocean and sea will continue. Field tests will be made on an instrument designed to measure small pressure fluctuations at great depth in an effort to sense very large wave-like disturbances of ocean currents.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0024, (U) OCEAN CIRCULATION MODELS

R.C. BEARDSLEY, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139

A rotating laboratory model which models the dynamics of the large scale wind driven ocean circulation will be used to investigate the interaction of Rossby waves with the mean interior and western boundary layer flow in an enclosed basin. The amplitude and phase response functions will be measured as the relative mean and oscillatory components of the applied stress are varied. A numerical study of the model equations for a steady stress will be compared with experimental results previously obtained to help understand the nature of the flow instability observed.

Many operations in the ocean are contingent upon knowledge of water movements and the associated physical property distributions. In turn, the goal of predicting three-dimensional configurations of ocean currents depends in large measure on improved understanding of fundamental processes involved.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0025, LONG RANGE SOFAR FLOATS

H.M. STOMMEL, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139 (NONR)

This is a field experiment concerned with measuring water motions at subsurface depths. Measurements will be made of long period and large scale ocean currents by acoustically tracking neutrally buoyant floats in the SOFAR channel. Fixed hydrophones in the sound channel will be used to locate and track the floats and to determine the ambient temperature at the float via transmitted CW pulses. These floats are large, expensive and recoverable. A second type of expendable, one- shot float is under design. The deployment of relatively many of these inexpensive floats could yield information regarding vertical shear and horizontal coherence of subsurface motions.

This is an important step towards understanding the large scale and long period motions of the oceans in the mid-depth range. It is also significant in that it fully recognizes the potential of the permanent sound channel for information telemetering.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0026, EASTERN BOUNDARY CURRENTS

I. SCHELL, Ocean Atmosphere Res. Inst. , *Cambridge, Massachusetts* 02138 (N00014-67-C-0334)

The objective of this task is to determine the influence of large- scale atmospheric conditions, such as pressure and wind field patterns, upon the Benguela Current and associate upwelling in the eastern South Atlantic Ocean. From the distribution of atmospheric pressure over the South Atlantic Ocean, indices of atmospheric circulation are being developed to describe the intensity of this circulation. These indices are then being correlated with both sea surface temperature conditions off southwest Africa and subsurface temperature, salinity and oxygen content for sections which extend seaward from areas of upwelling along the coast.

This is part of the Navy's basic research program intended to provide a better understanding of the operating environment of the Navy. The results from this study should contribute to the understanding of macro-scale air-sea interactions, and, in particular, the influence of large-scale atmospheric systems upon the dynamics and structure of the oceans which relate to acoustical propagation characteristics. From such better understanding of the large-scale influences of the atmosphere upon the oceans should develop improved environmental forecasts.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0027, CIRCULATION ON THE CONTINENTAL SHELF

D.F. BUMPUS, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

This investigator has endeavored to delineate the horizontal motions in the circulatory system of the continental shelf of the east coast of the United States. With the generalized pattern in hand we are trying to work out the secular changes in the circulation and their causes. We will use a Lagrangian technique with drift bottles at the surface and sea-bed drifters at the bottom and make use of all the physical oceanographic, hydrological, climatic and meteorological data and theory to elucidate these motions.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0028, GULF STREAM EDDIES

F.C. FUGLISTER, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

This is a continuing study of the Gulf Stream system in the region following its departure from the continental shelf off and east of Cape Hatteras. The objective is to gain a better understanding of the structure, behavior and frequency of occurrence of large-scale, cold- water eddies formed by the meandering Gulf Stream. This year emphasis is upon the analyses and interpretation of data from recent cruises concerned with the detailed documentation of the life cycle of a single eddy. This includes both descriptive aspects and the development of numerical models. A series of cruises also will be mounted to search for and tag both old and new eddies to determine the role these large -scale features play in the water mass structure of the northwestern North Atlantic.

It is essential to obtain a detailed quantitative description of the oceanic circulation on both a large and a small scale in order to establish a sound basis for predictions of oceanic structure and to isolate the physical, chemical, biological, and geological processes responsible for the ocean's behavior. The results from this study should assist the development of forecasting methods.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0029, GULF STREAM TRANSPORT

P.C. MANGELSDORF, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

It has been found that navigation methods now available can provide average surface current measurements between successive hydrographic stations precise enough to be combined with the calculated geostrophic shear to yield true total transport. A cruise of R/V CRAWFORD is scheduled for August 1967 during which it is planned to use this method to measure the total transport of the Gulf Stream system across two different sections extending from the Continental Slope to the Bermuda Rise. This grant provides funds for equipment and scientific personnel for this cruise, and for subsequent data processing.

SUPPORTED BY U.S. National Science Foundation

2.0030, INVESTIGATION OF SHALLOW CURRENT STRUCTURE IN THE WESTERN TROPICAL ATLANTIC OCEAN

W.G. METCALF, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

Further studies of the circulation in the shallow layers of the Western Equatorial Atlantic are proposed. The classical view of the current pattern shows that water of South Atlantic origin flows northwestward across the equator and enters the Caribbean Sea (and the North Atlantic circulation) by way of the Guiana Current.

2. WATER MOTION

Direct current measurements and a study of the hydrographic data in this area indicate that that portion of the water column between 13 to 24C, of South Atlantic origin, does not contribute to the circulation of the North Atlantic. In particular the oxygen concentration in the South Atlantic water is higher than in North Atlantic water through the same temperature range.

Sections of hydrographic stations and direct current measurements are planned to determine the circulation pattern between the mouth of the Amazon River and the Antilles Arc. Special emphasis will be placed in obtaining closely spaced samples through the upper 300 to 500 meters of the water column. Direct current measurements will be made using parachute drogues and a current meter designed to be lowered from the ship.

SUPPORTED BY U.S. National Science Foundation

2.0031, NORTH ATLANTIC CIRCULATION

L.V. WORTHINGTON, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

This task is concerned with the general circulation and water mass distributions of the ocean. It includes both the description of large oceanic features such as current systems and the study of the causes which produce changes in them. Particular emphasis is upon the measurement of the volume transport of the Gulf Stream south of New England using free drop instrument techniques. The validity of the hypothesis that sloping bottom topography controls meanders also is being re-examined using new bathymetric data. A water budget of volume transport and actual volumes of different water masses is being developed for the North Atlantic and the distribution of water mass properties in the Somali Basin are being determined.

This study should provide the understanding of the physical nature of oceanic circulation which has a bearing upon numerous problems in effective use of the oceans for military operations. It will provide the proper input to theoretical models of the circulation which are needed for the long-term goal of prediction of oceanic variables and further our ability to describe and predict the properties of the oceans.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0032, AN INVESTIGATION OF THE OVERFLOW OF NORWEGIAN SEA WATER INTO THE NORTH ATLANTIC THROUGH DENMARK STRAIT

L.V. WORTHINGTON, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

Observations made during the International Geophysical Year have indicated that the Norwegian Sea overflows are major sources of deep water in the North Atlantic. Past measurements have shown that the overflow between Iceland and the Faroes amounts to about 5 x 10 to the 6th power cubic meters/sec. The amount of the Denmark Strait overflow has not been determined. This research proposal is for a detailed examination of this overflow using both hydrographic measurements and current meters. The staff of the Bedford Institute of Oceanography have agreed to cooperate in this effort and the work will be performed aboard the Canadian Research Ship HUDSON.

SUPPORTED BY U.S. National Science Foundation

2.0033, VERTICAL CURRENT STRUCTURE IN THE GREAT LAKES

V.E. NOBLE, Univ. of Michigan, Great Lakes Research Division, *Ann Arbor, Michigan*

The objective of this program is to use the wind and current data from the buoy system established in the Great Lakes by the Public Health Service to gain an understanding of the dynamics of the current structure in the Great Lakes. These data are continuous, and have been obtained over a full-year period in Lakes Michigan, Ontario, and Erie. The buoy stations were placed so as to cover the entire basin of each lake. The buoy stations will be in Lake Huron during 1966, and will be moved to Lake Superior in 1967.

Preliminary analysis has shown a seasonal progression of the current patterns in Lake Michigan. This progression of patterns seems to reflect the change in the effectiveness of the air-sea coupling as a result of the air-sea temperature structure.

Detailed analysis of the available data will help to provide the conceptual framework for the development of a theoretical model which will accurately predict the current patterns observed in the Great Lakes.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

2.0034, OCEAN CIRCULATION AND CONTROLLING FACTORS FOR PREDICTION

G. NEUMANN, New York University, Graduate School, *New York, New York* 10003 (NONR)

Objective: The Navy needs for oceanic environmental information to plan and execute operations and to install fixed subsurface systems requires knowledge of the movements of water mass and currents as well as a capability to predict changes in them. This research is to determine the factors controlling organic circulation, both large-scale current systems and local upwelling phenomena. By providing a better understanding of the meteorological and oceanographic conditions controlling oceanic circulation, improved environmental prediction techniques may be developed to support naval operations.

Approach: The fresh water discharge of the Amazon River and the differences in precipitation and evaporation are being evaluated as causes for the large salinity variations observed in the upper strata of the Tropical Atlantic. Physical oceanographic data obtained from EQUALANT cruises in the area are being analyzed to determine seasonal variability. Oceanographic and meteorological data also are being collected, analyzed and correlated to determine the causes of anomalous temperatures frequently encountered in the waters off New Jersey.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0035, STUDY OF INFLUENCE OF STRATIFICATION ON CURRENT STRUCTURE

G. NEUMANN, New York University, School of Engineering, *New York, New York* 10003

This research proposal is concerned with the study of the circulation of Lake Michigan. Rotary currents with the local inertial period have been found to be very prominent in the data and frequently mask other long and short term current variations. In order to obtain more definitive clues as to their nature, it is proposed to separate these currents from the data by a least squares technique. This will enable us to study not only the vertical and horizontal structure of these rotary currents but also the residual circulation that remains after the rotary current has been subtracted.

SUPPORTED BY U.S. National Science Foundation

2.0036, VERTICAL OCEAN CIRCULATION

P.K. WEYLE, State University of New York, Graduate School, *Stony Brook, New York* 11790

The basic goal of this research is to increase the level of knowledge regarding convective processes within the ocean. Such knowledge will yield better understanding of how the ocean stabilizes our climate and how climatic distributions affect subsurface circulation in the sea. The first objective is to identify ocean areas capable of producing long-term effects on the subsurface circulation through the formation of distinct water types and to estimate the formation and mixing rates of such waters. During this year, the objective will be attacked by the development of a statistical, dynamic model involving knowledge of the distribution of all ocean waters on the basis of some measure of depth, as well as temperature and salinity. Only existing data will be used. (Preliminary studies indicate that the model will be more sophisticated than was expected because of complex equation of state of sea water).

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0037, CURRENT STUDY ON THE NEUSE RIVER AND ESTUARY

W.J. WOODS, Univ. of North Carolina, Institute of Marine Science, *Morehead City, North Carolina* 28557

A study will be made of water movements in the Neuse River and Estuary. Data obtained will be used to determine flushing rate and circulation patterns. This is the second phase of a study which it is hoped will ultimately determine flushing rates and circulation patterns in the Pamlico Sound complex. Pamlico Sound is a shallow, bar-built estuary in North Carolina.

A fluorescent dye (Rhodamine B or Rhodamine WT) will be added to the river and its distribution traced by boats equipped to pump water continuously through a Turner Fluorometer. The record of concentrations on successive days, as long as the dye is detectable, will be used to determine the rate and direction of water movement and the effect of wind and tidal action.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of North Carolina

2.0038, TIME DEPENDENT VARIATIONS IN SURFACE OCEANIC CIRCULATION

R.G. DOUGLAS, Case Western Reserve Univ., Graduate School, *Cleveland, Ohio* 44106 (AT(11-1)-1796)

It is apparent that in the future demands will be made upon the marine environment for many of the resources which are now available on land. These demands will take many forms, but probably the most important will be the increasing use of the oceans for: 1) waste disposal and, 2) food production. If the exploitation of the terrestrial environment can be taken as a guide (and present indications suggest that it can), increasing use of the oceans will significantly alter the marine environment, probably irreversibly. Before this occurs it is imperative that a comprehensive understanding of the phenomena which control the major physical characteristics of the marine realm be obtained. Since 1880, for example, the North Atlantic has experienced an average sea-surface temperature change of up to 3 degrees Centigrade, presumably due to changes in ocean currents resulting from minor climatic fluctuations. Such changes bear on the ultimate fate of wastes deposited in the sea and on the productivity of the world's fisheries which originate and are maintained largely through a delicately balanced combination of currents and temperature.

Because the oceans undergo time-dependent change, the prediction of oceanographic conditions -- necessary for intelligent utilization of the ocean as a resource -- can only partially be derived from study of the modern situation. To this must be added a historical perspective. It is necessary to know the direction and magnitude of changes which have occurred in the past and may be expected to recur. The necessary models of past conditions can be derived from detailed geological investigation of materials preserved in the sedimentary record on the sea floor. We propose to make an investigation which relates to the development of models of the surface circulation of the ocean under the most extreme conditions of the last few thousand years. Specifically we propose to develop the surface circulation model responsive to the fully glacial conditions which ended about 1,000 years ago, and to the conditions of 6,000 - 8,000 years ago when the earth was warmer than at any other time since deglaciation began. If we are successful in attaining this objective, we plan to examine the models responsive to the smaller scale changes of the last 6,000 years which will be of most interest in predicting future changes.

SUPPORTED BY U.S. Atomic Energy Commission

2.0039, TIME FLUCTUATIONS IN OCEAN CURRENTS

M.S. LONGUETHIGGINS, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Two related approaches will be taken towards the study of time-fluctuations in ocean currents having periods of the order of a few pendulum-days.

1. Theoretical studies - (a) Calculation of the normal-mode oscillations in ocean basins of ideal shape on a rotating sphere. The computations will take account of horizontal divergence and will span the whole range of Lamb's parameter. (b) Numerical evaluation of new types of wave motion associated with bottom topography, including (particularly the double Kelvin waves progagated along a straight) discontinuity.

2. Model experiments - Experiments will be made with a rotating fluid shell contained between two concentric spheres. The initial aim is to set up the shellular modes (those with zero radial velocity) and related wave motions.

SUPPORTED BY U.S National Science Foundation

2.0040, OCEAN CIRCULATION STUDIES

J.A. KNAUSS, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881 (NONR)

The work underway involves three aspects of physical oceanography (1) direct measurements of oceanic currents are being made with current meters, swallow floats and Richardson free-dropping buoys for mass transport calculations. In addition, hydrographic measurements are used for dynamic calculations. The work is concentrated in the area of the Blake Plateau where the Gulf Stream appears to cross the deep western boundary current and along the continental slope off New England. (2) fluid dynamics relations to non-linear mechanics, in particular the application of statistical mechanics to equilibrium phenomena. (3) the transfer of energy across the frequency spectra of internal waves.

Better understanding of ocean circulation is essential before models can be constructed for prediction of the variables which influence sound propagation, dispersion of contaminants, and navigation of deep running submarines.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0041, CURRENTS AND WATER MASSES IN THE SOUTHWEST ATLANTIC

L.R. CAPURRO, Texas A & M University System, Graduate School, *College Station, Texas* 77843

This is for the continuation of cruises to the Southwest Atlantic covering 150 oceanographic stations and six surface and deep current stations, the current measurements will be extended from thirty hours to one week and an additional research vessel will be included in the program. It is felt that the study of water masses and currents in this region and the associated front is of fundamental importance to an understanding of Southwest Atlantic circulation as well as to explain some of the observed geophysical phenomena in the Argentine Basin by the LGO scientists.

SUPPORTED BY U.S. National Science Foundation

2.0042, CIRCULATION STUDIES

J.D. COCHRANE, Texas A & M University System, Graduate School, *College Station, Texas* 77843 (NONR)

This task is concerned with the study of oceanic circulation in three distinct regions: (1) the eastern Gulf of Mexico and Cayman Sea, (2) the western tropical Atlantic, and (3) the eastern tropical Pacific Ocean. A cruise is scheduled to study the Yucatan Current to determine the onset of western intensification in the current as well as evidence of convergence and divergence patterns on the west side of the Campeche Bank. Ongoing analyses of other, previously-collected data are concerned with the origin and downstream modification of the Atlantic Equatorial Undercurrent and the eastern termination of the Pacific Equatorial Undercurrent.

The results from this study should provide a better understanding of the dynamics of the oceans in these little-known areas and assist in planning any future more-detailed surveys in these areas. Through a better understanding of the dynamics of the oceans also can evolve better methods for predicting current behavior.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0043, BOTTOM ENVIRONMENT--GULF OF MEXICO

W.E. PEQUEGNAT, Texas A & M University System, Graduate School, *College Station, Texas* 77843 (NONR)

The environment at the bottom is being studied in the deep waters of the Gulf of Mexico, where the depth exceeds 1700 fathoms. The objective is to understand the forces affecting bottom properties. To this end deep sea photography conbined with current meters, dredges and other sampling devices are used to relate biological populations, water motion, and chemical content to the observed physical properties of the bottom.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0044, CIRCULATION STUDIES

R.O. REID, Texas A & M University System, Graduate School, *College Station, Texas* 77843 (NONR)

This task includes both theoretical and field studies of ocean circulation with emphasis on the Gulf of Mexico. Theoretical models of the Gulf circulation will be treated as will the more general problem of western boundary currents in a layered ocean. A major effort is being directed towards the development of a 3-dimensional numerical model for describing the circulation and associated thermal structure of the Gulf. An observation program also is being mounted to monitor the inflow into the Gulf from the Yucatan Current for use in the numerical model. Another study is investigating the response of a stratified oceanic system and overlying stationary hurricane.

The results of this task should provide a better understanding of the circulation of the Gulf and the cause of spatial and temporal variations. Some generalization to other regions should be possible for forecasting purposes.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0045, CIRCULATION DYNAMICS (GULF OCEANOGRAPHY PROGRAM)

R.S. ARMSTRONG, U.S. Dept. of Interior, Biological Laboratory, *Fort Crockett - Galveston, Texas*

Studies have shown that variations in shrimp catches in the Gulf of Mexico are regional rather than local. This wide-spread effect suggests an influence corresponding to deviations from the normal oceanic environment.

Project goals involve (1) describing the stratification, currents, circulations, and distribution of properties as observed during pertinent periods; (2) defining deviations from the normal, and the rates of changes in climatic variations, seasonal fluctuations, and shorter time variations; and (3) relating the sea and the variations to the driving forces of wind-driven circulations, changes in the water budget, primarily by the volume transport throught the Yucatan Straits, and energy associated with heat budget.

The ultimate goal will be to develop usable, routine techniques for predicting the state and character of the waters at any locale in the Gulf.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0046, FINE STRUCTURE FEATURES OF TEMPERATURE AND SALINITY AT WATER MASS BOUNDARIES IN PACIFIC

G.I. RODEN, Univ. of Washington, Graduate School, *Seattle, Washington* 98122 (NONR)

Objective: An understanding of the temperature and salinity small-scale variation in the transition zone between the subarctic and subtropical water masses of the North Pacific is important to the Navy for sound propagation and the prediction of oceanographic and meteorological conditions that influence naval operations. This research is to better understand the circulation patterns and their relationship to the fine structure of temperature and salinity observed at the boundary of these water masses which extends from Japan to Mexico between 31 and 43 degrees north latitude.

Approach: A detailed observational and theoretical study of the eastern part of the transition zone between 145 degrees west longitude and the American mainland will be made. The fine detailed temperature- salinity structure and oceanic circulation will be investigated. Temperature, salinity, dissolved oxygen and nutrients will be measured. The processes leading to the formation of the transition zone and detailed temperature-salinity structure will be theoretically investigated. The time variability of temperature and salinity in the zone also will be assessed from meteorological and oceanographic information collected on Ocean Weather Station NOVEMBER.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0047, BOTTOM CURRENTS AND THE MOVEMENT OF SEDIMENT ACROSS THE CONTINENTAL SHELF

R.W. STERNBERG, Univ. of Washington, Graduate School, *Seattle, Washington* 98122 (AT(45-1)1752)

Field, experimental, and theoretical work is proposed in several areas as part of the initial stages of an investigation of sediment transport on the continental shelf. In order to relate the general physical oceanography of the shelf to the bed load sediment transport, procedures for accurate calculation of the boundary shear stress must be available. In general, this requires an understanding on non-uniform and unsteady turbulent boundary layer mechanics. Such boundary layers are to be studied in the field using a marine Preston tube in conjunction with a bottom mounted array of rapid response current meters. These two systems give three nearly independent ways of evaluating the boundary shear stress in quasi-uniform quasi-steady flows providing a check on the method presently being used as well as permitting extension of our experimental capabilities to flows hitherto precluded by instrumental limitations. Theoretical and laboratory work on this problem and the related sand wave problem will continue. In addition, field measurements of bed load transport and boundary shear stress will be used to check the validity of the standard bed load equations in the marine environment. Moreover, the boundary shear stress at which sediment motion is initiated and the nature of sand waves will be investigated more thoroughly using the underwater television system, the stereo cameras, and the marine Preston tube. Theoretical work on these sediment transport aspects of the problem will continue. Field work will be carried out in Puget Sound and in the Columbia River during the next contract year. However, in the subsequent year a major part of the offshore work is expected to begin.

Results to Date: In the past few years considerable data has been accumulated on the variation of the drag coefficient relating the boundary shear stress to the flow one meter from the bed with flow conditions and bottom configuration. Information which confirms the use of the Shield's initial motion criterion in the marine environments has also been obtained. Recent results obtained by this project include successful flume measurements of the shear stress and velocity distributions over model sand waves, measurements of Reynolds stress in a tidal channel, measurements of the structure of the tidal flow near slack water, and measurements of boundary shear stress with a marine Preston tube.

SUPPORTED BY U.S. Atomic Energy Commission

2.0048, INVESTIGATION OF THE CIRCULATION OF LAKE SUPERIOR

R.A. RAGOTZKIE, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

The overall goal is to describe and explain the general circulation of Lake Superior throughout the year. Studies have revealed that there are persistent cold cells in Superior, at least until early August, and a narrow and relatively fast surface current flowing northeast along the Keweenaw Peninsula.

Gradient currents calculated from temperature cross-sections in the nearshore region north of the Keweenaw Peninsula indicate currents velocities excess of 1 knot flowing in a northeastward direction. Current measurements from buoys confirm these calculated currents. This boundary current flows from mid-June until at least early September.

Theorectical studies have shown that for a stratified fluid in an enclosed basin the size of Lake Superior, the natural free mode of circulation includes high velocity boundary currents in a cyclonic direction. These may also occur in Lakes Huron and Ontario.

Circulation studies in a rotating laboratory model of Lake Superior also suggest this circulation in the epilimnion. Further analysis of field observations and laboratory experiments is continuing. Additional airborne infrared temperature mapping and in situ current measurements are planned.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Wisconsin

2B. CONVECTION-MIXING-UPWELLING

2.0049, TRACERS STUDIES IN ALASKAN HARBORS

D.L. WORF, Univ. of Alaska, U.S.D.I. Alaska Water Lab. , *College, Alaska* 99735

Tidal flushing and estuarine water flowing into harbors are the primary means for diluting the industrial and community pollutants discharged into these harbors. The mechanics of this dilution is complex and not well known. The objective of this proposal is to use tracers (dyes and radioisotopes) to measure the rates of dilution at various points in the channel. Variables are seasonal fluctuations in fresh water flow, temperature, amount of natural and man-made wastes discharged into harbors.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

2.0050, DISPERSION PROCESSES IN ESTUARIES AND RIVERS

H.B. FISCHER, U.S. Dept. of Interior, Water Resources Division, *Menlo Park, California*

Purpose: To determine the mechanics of the dispersion process in streams and estuaries chiefly by the use of previously derived and newly developed analytical and numerical theories and to suggest modifications and more effective methods of analysis.

Methods: Rhodamine WT and Rhodamine B dyes are being used to study longitudinal and lateral dispersion on bays, estuaries, and large streams. Hydraulic models will be constructed to ascertain differences in the models and prototype streams selected for comparative purposes.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0051, DISPERSION IN HYDROLOGIC AND COASTAL ENVIRONMENTS

N.H. BROOKS, Calif. Inst. of Technology, School of Engineering, *Pasadena, California* 91109

Hydrodynamics problems of dispersion in hydrologic and coastal environments will be studied theoretically, in the laboratory, and in some instances in the field. The various areas and problems to be considered are:

(1) Natural rivers: longitudinal dispersion, transverse turbulent diffusion, velocity distributions. (2) Reservoirs and lakes: artificial large-scale mixing; buoyant plumes in stratified environment. (3) Ground-water basins: source of buoyancy in a current; free and forced convection. (4) Estuaries: longitudinal dispersion. (5) Oceans (nearshore): buoyant plumes in a current; sewage field thickness; large scale diffusion.

Turbulent diffusion and density-stratified flow phenomena are common to several areas above.

Work will not be conducted in all areas simultaneously but rather a continuing program at a modest level will be developed.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

2.0052, BIG EDDIES AND MIXING PROCESSES IN THE GREAT LAKES

G.T. CSANADY, Univ. of Waterloo, School of Engineering, *Waterloo - Ontario, Canada*

Disposal of domestic and industrial waste in the Great Lakes requires a knowledge of the mixing processes involved. Previous work of the principal investigator and his collaborators has shown that mixing in the vertical depends critically on the supply of relatively large eddies, occurring in a more or less organized pattern, and often giving rise to a streaky appearance of the lake surface. The physical mechanism causing such 'streaking ' is not known (although several speculative explanations have been proposed), nor is it clear what eddy structure would be set up in a wind driven current or in a gradient current, or how such structure would be modified by convective effects due to surface cooling. The object of the present project is to investigate the eddy structure of the surface layers of the Great Lakes, particularly as regards big eddies (which are known to determine mixing processes in turbulent flow) and relate this to observable diffusive properties of lake currents.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

2.0053, TRITIUM AS A TRACER FOR MIXING PROCESSES

G.H. OSTLUND, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

This is a continuing study of the distribution of fusion-bomb produced tritium in the equatorial Atlantic. Combined with salinity distribution the tritium data have yielded insight into the relative roles of horizontal and vertical mixing. Cruises in 1965 and 1967 have collected some 320 samples from the Equatorial Atlantic Current System and it is proposed to complete these analyses. The implications of these data will be investigated, relative to mixing processes, origins and time scales of components of the current system, etc.

SUPPORTED BY U.S. National Science Foundation

2.0054, MIXING PROCESSES INFLUENCING THE OCEANIC ENVIRONMENT

C. ROOTH, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124 (NONR)

Objective: The prediction of oceanic environmental conditions influencing naval operations and the effectiveness of naval systems and equipments requires an understanding of the physical processes causing changes within the environment. The aim of this research is to determine the nature of mixing processes such as those in the surface layers that influence the thermal structure, and those at the seabed influencing the operation of underwater facilities.

Approach: Analyses are being made of material from previous laboratory experiments and field studies on entrainment effects and turbulence penetration in pycnoclines and on oceanic velocity spectra obtained from moored current-meter arrays. They are to be the basis for the formualtion of a mixing theory for the interior of the oceans. The effects of density-modifying processes acting at the lateral boundaries of a basin (frictional mixing and geothermal heat flow) also are being studied with a number of theoretical and laboratory models.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0055, STUDY OF OCEANIC TURBULENCE

B. GALLAGHER, Univ. of Hawaii, Graduate School, *Honolulu, Hawaii* 96822

Increased knowledge of the structure of oceanic turbulence is necessary to further understanding of the dynamics and transport processes in the sea. It is proposed to begin measurements of this structure in a deep ocean location where the spatial nature of the turbulence is expected to be least complex. The measurements are designed to reveal the spatial structure of the motion in a form to which turbulence theories can be applied. Values for parameters of energy dissipation and vertical diffusion will be found.

SUPPORTED BY U.S. National Science Foundation

2.0056, TURBULENT DIFFUSION STUDY

D.W. PRITCHARD, Johns Hopkins University, Graduate School, *Baltimore, Maryland* 21218 (NONR)

The aim is to study turbulent diffusion in estuarine and coastal waters. Emphasis during the coming year is upon the effects of spatial variations in the velocity field on the shape and concentration distribution of a cloud introduced as an instantaneous local source. A field experiment will be conducted in Chesapeake Bay to obtain data on the relationship between the local shear in the horizontal velocity field and the shape, during early stages of dispersion of a nearly instantaneous source. Other field studies include the study of vertical diffusion through the pycnocline in a tidal estuary and the study of large scale advective and diffusive processes which control the longitudinal distribution of salinity in an estuary.

This study will contribute to understanding short-term small-scale fluctuations in temperature in shallow water and estuarine areas as well as to the fate of contaminants introduced deliberately or accidentally.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0057, EXPERIMENTAL AND THEORETICAL STUDY OF THE HYDRODYNAMICS OF DISPERSION IN RIVERS AND ESTUARIES

M.P. TULIN, Hydronautics Incorporated, *Laurel, Maryland*

The general aims of the proposed research are: 1. To improve understanding of river hydraulics inasmuch as it has a bearing on dispersion. 2. To develop methods enabling the calculation of the velocity distribution in streams, which may be used to determine the dispersion coefficient, and to provide systematical experimental assessment of the results. 3. To provide experimentally verified, quantitative results relating to dispersion in channels with varying aspect ratio and boundary roughness distribution. 4. To develop quantitative verified theories relating components of the dispersion tensor to the mean flow characteristics. 5. To provide useful and verified information and procedures relating to the scaling and model testing of dispersion in streams.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch

2.0058, RESEARCH ON TURBULENT CONVECTION

E. MOLLOCHRISTENS, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139

Turbulent convection is one of the important processes in geophysical fluid mechanics. The research was for the purpose of obtaining more information about the phenomenon from laboratory experiments performed under controlled conditions. The experiments involved observations of statistical measures of the turbulent fluctuations, such as spatial covariance, time and space intermittency, spectra in frequency and wave number. Turbulent convection in a stratified medium was also investigated.

SUPPORTED BY U.S. Dept. of Defense - Air Force

2.0059, RESEARCH IN OCEANIC PHYSICS

H.M. STOMMEL, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139

The program centers about a field study of the small scale structures and mixing processes within the main thermocline of the subtropical Atlantic ocean. Various new forms of instrumentation will be used to measure shear, density stability, and life history of laminae on vertical scales of less than ten meters. The field study is scheduled for the Research Vessel ATLANTIS II on August 28 - September 19, 1968, southeast of Bermuda.

Theoretical study of the Ekman layer in the presence of strong heating and application to the Trade wind region of the ocean is contemplated. Also a laboratory model-study and theoretical study of density tongues in rotating density-stratified fluids is being pursued: with the hope of eventual application to interpretation of the spreading of water-masses at depth.

During the Spring of 1969 an attempt will be made to locate, identify, and intensively survey a region of active bottom -water formation in the Ligurian Sea. A continuous monitoring of the cold- upwelling region off Somalia, associated with the Monsoon induced Somali Current is also in progress in the hope of providing definite information on the time of response of an ocean current to variable wind-stress. The latter investigations are meant to be part of the U.S.-Italy Cooperative Science Program.

SUPPORTED BY U.S. National Science Foundation

2.0060, VERTICAL MOTIONS

A.D. VOORHIS, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

Experiments are being carried out to measure vertical motion and vorticity in depths ranging from 300 to 3000 meters of water in the northwest North Atlantic. Neutrally buoyant floats with vanes that cause rotation as water moves vertically past them are being used. Rotation is reported acoustically to the tending ship. An experiment is to be carried out in the vicinity of a moored array of current meters to study the partition of kinetic and potential energy in the oceans. Other measurements also will be made at the edge of the Gulf Stream where turbulence is high.

Little is known about the vertical movement of water in the oceans. This program is attempting to measure such movement. It influences the displacement and deployment of naval systems in deep water. Therefore, the magnitude of such motions should be known and sufficiently understood to predict them.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0061, SALINITY INTRUSION AND RELATED PHENOMENA

H.B. SIMMONS, U.S. Army, Waterways Experiment Sta. , *Vicksburg, Mississippi*

The objective of this project is to determine, for conditions of open channels subject to salt-water intrusion and tidal oscillations from the sea, the factors which control the extent of salinity intrusion, the degree of vertical mixing of salt and fresh water, the magnitudes and durations of current velocities at all depths, and the movement and deposition of sediments as influenced by density effects.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0062, CHARACTERISTICS, CAUSES, AND PREDICTION OF UPWELLING WATER MASSESS OFF OREGON

R. SMITH, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Objective: The efficiency of search and rescue, underwater construction and other operations can be strongly influenced by the character and motion of water masses in the operating area. One commonly occurring and very distinct water mass off the west coast of the U. S. results from an intermittent upwelling of deep cold water into the near surface water. A thorough understanding of this upwelling process and the associated changes in horizontal currents and water properties should allow their prediction both in the study area and in similar areas elsewhere in the world.

Approach: Interrelationships between upwelling, tides, local weather, water properties and currents are being studied using concurrent measurements of sea level, atmospheric pressure, and the temperature, salinity, and oxygen content of water. In addition information on currents is being obtained both from tracking drogues which drift with the currents and from fixed current meters anchored above the continental shelf. A team of qualified researchers, mostly advanced graduate students, is carrying out detailed but coordinated studies on various aspects of the program. As the interrelationships become more clearly defined, predictive models will be constructed and tested.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0063, CATALYSIS AND KINETICS OF MANGANOUS ION OXIDATION IN AQUEOUS SOLUTION AND ADSORBED ON THE SURFACES OF SOLID OXIDES

R.W. COUGHLIN, Lehigh University, School of Engineering, *Bethlehem, Pennsylvania* 18015

In view of the several mechanisms which have been proposed for the formation of manganese nodules, and because of the need for further quantitative data on manganese chemistry, this proposal sets forth a program which would: 1. Study the adsorption of soluble manganese from aqueous solution on the surfaces of various solid oxides (especially those of manganese and iron) with the goal of obtaining information about the nature of adsorption and double-layer formation. It will be of special importance to investigate the effects on these processes of foreign ions, complexing molecules, etc. 2. Study kinetics and mechanisms for the oxidation of manganous ions both in aqueous solution and at solid oxide surfaces (expecially those of manganese and iron). The possible catalytic action of these surfaces will be of special interest.

SUPPORTED BY U.S. National Science Foundation

2.0064, HORIZONTAL DISPERSION IN SHALLOW ESTUARIES OF IRREGULAR SHAPE

F.D. MASCH, Univ. of Texas, School of Engineering, *Austin, Texas* 78712

This proposed research involves the development and verification of a numerical model to evaluate transport characteristics in shallow vertically-mixed estuaries of irregular shape. The model is designed to assist in developing water quality requirements and evaluating the assimilative capabilities of the shallow irregular estuaries found along the Gulf Coast of the United States.

The study includes the following three phases: 1. Adaptation of an explicit numerical model of the two-dimensional convective dispersion equation to the irregularly-shaped estuary. 2. Evaluation of the dispersion coefficients from graphical and analytical considerations of the circulation and scale of turbulence in the estuary. 3. Verification of Phases 1 and 2 in a hydraulic model and then in the field.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Texas

2.0065, COLUMBIA RIVER EFFECTS IN THE NORTHEAST PACIFIC

C.A. BARNES, Univ. of Washington, Graduate School, *Seattle, Washington* 98122 (AT(45-1)-1725)
WHETTEN

This study, started in 1961, aims to describe quantitatively the Columbia River water and its load of materials in the Northeast Pacific, stressing the movement, mixing, growth, and decay of the lobe of river water throughout the year and unique physical, chemical, biological, and geological properties that identify these waters. An attempt is made to relate conditions found with causative oceanographic and meteorological factors, to explain pertinent processes, and to establish a base for predicting general behavior at sea of river water and its transported load.

Analysis and interpretation continue of conventional oceanographic measurements and collections made on 60 cruises, covering 165,000 kilometers in 825 days at sea and providing 154,000 water samples; 14,900 productivity measurements; 8200 phytoplankton, 2500 zooplankton, 2400 sediment samples; in situ gamma-activity measurements; seabed drifter movement; and miscellaneous samples and observations.

Columbia River effluent moves in response to wind and current, north in winter and south in summer. Nutrients and dissolved oxygen have been correlated with mass properties and with the productivity and distribution of phytoplankton. Phytoplankton studies include productivity-chlorophyll ratios, taxonomic composition, size distribution, seasonal and diurnal variations, and response to light. Preliminary attention has been given to zooplankton speciation and abundance and to benthos. The bathymetry 500 km seaward from Washington and Oregon has been described, and initial reflection studies made of the subbottom. Mineral types, mechanical characteristics, chemical nature, microorganisms, radioactivity, and movement of the sediments have been described in part, and lower river reservoirs have been examined for characteristics, configuration and movement of bottom sediments. Detailed observations currently are being made near the river mouth, at the edge of the river plume, and of water and sediment movement near bottom. Coordination is maintained with pertinent ONR, NSF, ESSA, USGS, other AEC projects and with local Pacific coast groups, including Canadian.

SUPPORTED BY U.S. Atomic Energy Commission

2C. GENERAL WATER MOTION

2.0066, UNSTEADY FLOW AND SALINE INTRUSION IN ESTUARIES

R.A. BALTZER, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

It is of fundamental importance to recognize that flow in natural channels is basically unsteady flow. To be sure, the degree of its unsteadiness is often of such minor significance that, with sound reason, such flow can be assumed to be steady flow, thereby taking advantage of greatly simplified analytic representation. Nevertheless, proper and thorough understanding of the mechanics of unsteady flow is important per se in determining the discharge of regulated streams, in flood routing, in determining flows in tidal reaches of homogeneous density, and, in fact, in any situation where open-channel flow cannot be assumed to be steady flow. Moreover, an understanding of the mechanics of unsteady flow is fundamental to improving the understanding of saline intrusion and diffusion in estuaries.

The ultimate objective of this investigation is the development of mathematical models representing unsteady open-channel flow, particularly as associated with estuarine channels. These models, hopefully, could then be used to predict flow using certain field obtained parameters -- to determine such quantities as outflow, saline intrusion, and effects of channel changes upon flow.

A thorough appraisal of present knowledge of unsteady, open-channel flow is being conducted, including categorization of flow types and their required mathematical representation. Mathematical models will be derived and evaluated utilizing various solution techniques employing both analog and high-speed digital computers. Selected field data will be employed in the evaluation process.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0067, HYDROLOGY OF UPPER OLD TAMPA BAY, FLORIDA

J.A. MANN, U.S. Dept. of Interior, Water Resources Division, *Tallahassee, Florida*

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of Florida.

Purpose: To provide data for evaluating the hydrological effects of conversion of the bay into a fresh water lake and information by which to judge the feasibility of similar plans in other areas of the State.

Methods: The study will include the area of the proposed lake and an additional 25 to 35 square miles of land adjacent to the lake in Hillsborough and Pinellas Counties. The quantity and quality of surface and ground-water inflow into the bay will be determined. Continuous conductivity and stage gages will be installed on the lake and the bay, and on selected wells in the area to determine the degree of interconnection between the aquifers and the fresh water lake. Conductivity traverses will be made of the upper part of the bay, supplemented by sampling sites, to determine ground-water discharge into the bay. An evaluation will be made of existing geologic and hydrologic data to determine the relation between changes in water quality and ground-water storage. The areal extent, thickness, and permeability of clay beds underlying much of the area will be determined. The fresh water-salt water intergace will be monitored continuously.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey
Florida State Government

2.0068, STUDY OF LOW FREQUENCY SURFACE WAVES IN THE PACIFIC OCEAN

G.W. GROVES, Univ. of Hawaii, Graduate School, *Honolulu, Hawaii* 96822

Movement of water in the ocean is related to vertical movement of the sea surface, but in a way which is not yet clear. As soon as a relation is established, it will be possible to use tide gauge records to study historical variations in oceanic water movement and their long-term statistical properties. The object of this present work is to study movement of the sea surface and to try to account for the observed activity in terms of local weather, planetary waves, turbulence, etc. Long series of tide -gauge and weather data at Pacific Islands will be used. Cross spectra and other statistical properties of sea level and weather at one location, as well as at different locations will be studied. Existing theories, especially the planetary wave theories of Longuet-Higgins, will be found compatible or incompatible with the results.

SUPPORTED BY U.S. National Science Foundation

2. WATER MOTION

2.0069, OCEAN KINEMATICS DYNAMICS

D.W. PRITCHARD, Johns Hopkins University, Graduate School, *Baltimore, Maryland* 21218 (NONR)

The purpose of this study are: (1) to measure the turbulent velocities in estuaries and coastal waters corresponding to eddy scales of the order of centimeters to 100 meters (2) to determine the statistical character of the turbulent velocity fluctuation in this scale range; (3) compare turbulent velocity spectra with theory; and (4) determine influences of boundaries, stability and wave induced motion on velocity spectra in this scale range. During the coming year, analyses of data from a field program in June 1967 will be completed and a field program in a Chesapeake Bay tributary will be undertaken to study spatial coherence and boundary effects upon turbulent eddies.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0070, THEORY OF LARGE-SCALE ATMOSPHERIC AND OCEANIC PROCESSES

J.G. CHARNEY, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139

The objective of this work is to continue to apply analytic, computational and experimental methods to the study of a large-scale atmospheric and oceanic processes with the intent of incorporating these methods into mathematical models of the general circulation.

The work is subdivided into several parts: (1) tropical circulations - includes the development of a two-level numerical model for studying the symmetric Hadley ITC circulation and its interaction with asymmetric wave-circulation at higher latitudes, problems of the growth of disturbances in the ITC, and the relation of cumulus convection to the large scale field of convergence in the boundary layer; (2) equatorial jets - includes work on a theory of combined wind-driven, thermohaline equatorial undercurrent in a baroclinic ocean and numerical integration to obtain explicit solutions; (3) wave propagation in ocean and astmosphere - includes theoretical and observational work on inertial oscillations in the ocean, the manner in which large-scale eddy motion in mid-latitudes arising from baroclinic instability might propagate to low latitudes, and a check on predicted v spectra in the tropics with computations of v spectra from observations; (4) mathematical problems in numerical weather prediction - includes programming basic numerical prediction barotropic and baroclinic models for use in several types of numerical work including short-range prediction and the development of an objective analysis scheme; and (5) miscellaneous - includes the development of a numerical model to study the circulations produced in polar seas by the freezing of surface waters and work on mechanically and thermally produced symmetric circulations in a spherical annulus.

SUPPORTED BY U.S. National Science Foundation

2.0071, OCEAN DYNAMICS EXPERIMENTS

N.P. FOFONOFF, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

This is primarily a program of field observations and experiments. Its objective is a better understanding of the kinematics and dynamics of internal motions of both surface and deep waters. Concomitant development of instrumentation for time series measurements of velocity and thermal structure is necessary. Specific characteristics being studied are the frequency spectra of mechanical energy and their spatial distributions. Operational facilities include ships, moored buoy arrays and neutrally-buoyant floats as well as shore side computer, shop and office facilities. Direct measurements of time series of velocity and temperature are made by specialized internally recording packages. To date measurement sites have been limited to the western North Atlantic.

This study is expected to provide improved understanding of the variability of the environment. Improved knowledge of internal motions in the sea will have an impact on the planning and execution of subsurface resuce, recovery and assistance missions.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0072, OCEAN DYNAMICS EXPERIMENTS

N.P. FOFONOFF, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

The objective is to gain an understanding of the ocean as a dynamic system in all of its complexity. This is being pursued through time series measurements of the spectra of horizontal kinetic energy and associated fluctuations in the internal temperature field. The program for the first six months of 1968 is intended to carry out a sequence of steps which are necessary in order to reach the long-term goals. In doing so, the proposal departs from those of recent years. The commitment to a program of systematic measurements at particular sites has been temporarily shelved. In its place, a flexible program giving first priority to studies aimed at improving the performance of moorings and instruments has been substituted. As soon as a better capability for retrieval of moorings is achieved, it is proposed to return to a program whose main emphasis is scientific.

This study is expected to provide major improvement in our understanding of kinetics and dynamics of the ocean which will have an impact on the design of high speed deep running vehicles of the future. It also provides understanding of the variability of the environment.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0073, STUDIES IN THE INDIAN OCEAN

A.R. MILLER, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

The objectives are: (1) to process and analyze data collected from field work in the Indian Ocean during the International Indian Ocean Expedition with respect to problems of physical oceanography; (2) to determine the circulation of the Western Indian Ocean in whole and in its parts, from the data at hand; (3) to make use of and extend the capabilities of computer techniques insofar as they are related to the general problem of Indian Ocean circulation.

The general problem is to determine the effects of the monsoon system on the circulations. These effects are interactive. Consequently, the various phenomena observed appear to be closely related seasonally and causally. Transport losses, for instance, indicate significant transfers of moisture to the meteorological environment. Observed strong upwellings, while associated with coastal regions, are related to the westward intensification current. This current, in turn, is continuous with a major system south of the equator. The changing monsoon, in part, may be considered a controlling element over the general circulation and, in part, a major driving force. Peripheral seas provide a deep circulation whose effects may also be seasonal in character.

Two major cruises of ATLANTIS II to the Indian Ocean have provided data for this study. Thes will be combined with data obtained by other research vessels such as the DISCOVERY, METEOR, DIAMANTINA and KISTNA. Data will be shared with other participants of the Expedition as they are processed and become available.

SUPPORTED BY U.S. National Science Foundation

2.0074, GREAT LAKES RESEARCH - HARBOR CURRENTS

J.G. HOUSLEY, U.S. Army, Lake Survey, *Detroit, Michigan* 48226

Objective is to acquire data on winds, currents, waves, water-level fluctuations, atmospheric pressure variations, and lake currents in the vicinity of harbors in order to determine their effect on currents in harbors, and pollution hazards engendered by the lack of currents. Mathematical equations or models will be derived relating currents in harbors with their causative forces and harbor geometry. Flushing rates will be established. The results are applicable to the design or redesign of new and existing harbors, including approach channels.

Currents were measured: 1964 in Calument, Racine, Muskegon, and Sturgeon Bay harbors; 1965 in Little Lake, Fairport, and Buffalo harbors; and 1966 in Harbor Beach and Toledo harbors. Data and analysis of currents and associated variables in Little Lake Harbor, Lake Superior, was published in 1966. During FY 69 analysis of the data will be continued, and preparation of reports for the various harbors will be continued.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0075, FLOW AND SALINITY IN THE HUDSON ESTUARY, NEW YORK

M.W. BUSBY, U.S. Dept. of Interior, Water Resources Division, *Albany, New York* 12201

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of New York.

Purpose: To define the physical and chemical characteristics of the water in the estuary in order to provide a basis for management of this resource.

Method: River stage at each end of a reach (Poughkeepsie to Clinton) is continuously recorded. These time-synchronized stages are used with the power series method developed by Baltzer and Lai to compute tidal volumes. Water conductivity and temperature are continuously recorded at Poughkeepsie, Beacon, Peekskill and Peirmont. The conductivity data (a measure of salinity) will be related to tidal volume and movement and to fresh-water inflow as measured by several gaging stations on tributaries to the estuary.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey
New York State Government

2.0076, PHYSICAL OCEANOGRPAHY IN OREGON SHELF AND SLOPE WATERS

J.G. PATULIO, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Study of the dynamics and the physical properties of the water over the continental shelf and slope off Oregon will be continued. Competence in using moored recording current meters and thermographs on the continental shelf and in the analysis of the time-series obtained has been acquired during the past two years.

It is proposed that the measurement program on the shelf be continued and expanded to allow 3-dimensional arrays of instrument strings to be used. This expanded program will allow determinations of the spatial scale of the upwelling phenomenon, temperature inversions, inertial current flow, etc. The static and the dynamic stabilities which influence mixing will be studied, particularly in the region of the temperature inversion. It is further proposed to extend the measurement program offshore to study the water above the continental slope. The continental shelf and slope waters are dynamically interesting because the upwelled water moving offshore meets oceanic water to form a front. The slope region is also where we expect the subsurface poleward flow that many workers think characteristic of a coastal upwelling region.

The longer time-series records will allow investigation of the response of the coastal regime to longer period atmospheric systems. Detailed descriptive statistical analyses will be made of all data. The feasibility of prediction will be studied. Construction of a numerical model for prediction will be made based on the various transfer functions obtained from the time -series measurements.

SUPPORTED BY U.S. National Science Foundation

2D. TIDES-SEA LEVELS-SEA STATES

2.0077, GRAVITY AND EARTH TIDES

L.B. SLICHTER, Univ. of California, Inst. of Geophys. & Pla. Phys., *Los Angeles - U.C.L.A., California* 90024

Attempts to determine the difference, in amplitude and phase angle, between observed and theoretical earth tides will be made. Measurements of the long-period fortnightly tide and the earth's free vibrations will be obtained in Antarctica where undesirable noise from perturbations in the earth's rotation is minimal.

This research is of basic importance in determining (1) the physical nature of the materials forming the solid earth, and (2) the response of the solid earth to tidal forces. Such information has direct bearing on seismic wave propagation, tides in the open ocean, and the deformation of continental margins by ocean tides.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0078, INTERRELATIONS WITHIN THE PHYSICAL ENVIRONMENT

J.F. SAUR, U.S. Dept. of Interior, Biological Laboratory, *Palo Alto - Stanford, California*

The ultimate objective of the Ocean Research Program is to attain the capability of predicting the abundance and distribution of commercial fishes and thereby increase the efficiency of their harvest. This requires not only information on the state of oceanographic conditions, but also on the physical processes that bring about changes of the state of conditions as they occur with the passage of time. The interacting processes involved in a chain of events will determine the magnitude, time lags and persistence, all of which are pertinent to prediction. Knowledge of the processes leading to the event will also provide insight as to their effect on the biotic community supporting the fish population. For instance, the temperature of a region may be changed either by incursion of a different water mass or by an alteration of heat exchange across the air-sea interface. In the one case a new plankton community will be brought into the region and in the other a new set of conditions would be imposed on plankton community already populating the region.

The objectives of this project are to describe and to reach an understanding of the nature of the interrelationships occurring between parameters of the physical environment, that is, the magnitude and duration of changes, the time lags between changes in the parameters, and the interdependence between parameters. Primary effort under the project at this time is a study of variations of monthly mean sea levels and their relation to atmospheric conditions and density structure of the ocean.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0079, A GLOBAL DIRECTORY OF TIDAL CONSTANTS

M.C. HENDERSHOTT, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

All available tidal constants derived from observations at coastal and island stations are being collected into an updateable directory written on magnetic tape from which the constants over an arbitrary coastal on island arc may be extracted in the form needed in constructing cotidal maps.

SUPPORTED BY Alfred P. Sloan Foundation

2.0080, OCEAN WAVES AND TIDES

W.H. MUNK, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (NONR)

The objective of this investigation is to study tides in the open ocean and concurrently, temperature variations and water motion near the sea bed. The program includes the development of instrumentation and field measurements. During the coming year, a field experiment will be conducted to determine the horizontal coherence of tidal curents and long waves immediately above the bottom in deep water. The thermal and velocity structure of the benthic boundary layer also will be investigated and methods for analyzing time series will be improved.

The Navy is embarked upon a deep ocean technology program designed to improve man's capability to work and install equipment on the ocean floor. In addition, sound propagation is affected by physical variations in the deep ocean waters. This effort will provide knowledge of the variations and causes of such variations pertinent to these problems.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0081, STUDIES OF BARACLINIC TIDAL MOTIONS ON THE CONTINENTAL SHELF OF THE EASTERN UNITED STATES

P.P. NIILER, Nova University, Graduate School, *Fort Lauderdale, Florida*

Large baroclinic tidal motions occur in the Florida Straits and there is evidence for their existence also on the Blake Plateau. It is proposed to carry out a theoretical and experimental analysis to explain their nature and cause. The theories will be related to exisiting field measurements and new experiments will be designed to test the theories in a critical manner.

2. WATER MOTION

SUPPORTED BY U.S. National Science Foundation

2.0082, THE NET EFFECT OF WIND ON RECREATIONAL TIDAL STREAMS IN FLORIDA

D.H. MOREAU, Univ. of Florida, School of Engineering, *Gainesville, Florida* 32601

Wind stresses acting upon the surface of these shallow tidal rivers and their embayments along portions of the Gulf coast of Florida at times other than during storms can bring about water level changes as great as those resulting from the periodic tide producing forces. The development of procedures to determine the net effect of wind and astronomical tides upon water levels in these tidal rivers is becoming increasingly important with respect to their influence upon recreational use of the river and upon the aquatic environment of the rivers and their estuaries.

The basic data for this correlation study will be that which has been recorded at Cedar Key, Florida for the period July 1, 1963 through June 30, 1964.

It is proposed that the data be subjected to a time-series analysis consisting of the resolution of the data into two components: (1) an oscillatory series representing astronomical tidal action, and (2) a residual series representing the effect of wind and possibly the interaction of wind and astronomical tidal action.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Florida

2.0083, SPECTRAL ANALYSIS OF TIDAL CURRENTS

V. GRAEFE, Univ. of Hawaii, Hawaii Inst. of Geophysics, *Honolulu, Hawaii* 96822

Current data that had been collected under the direction of K. Wyrtki near the Hawaiian Islands were analyzed to determine the direction from which the diurnal and semidiurnal tides approach Hawaii. Fifteen series of current data, each covering a period of three to four weeks, had been obtained at ten locations near the Hawaiian Islands, and two series near Palmyra Island. The data of each series were first subjected to a linear filter that rejected all frequencies lower than 1 cpd or higher than 2 cpd, and then a Fourier analysis was performed. The diurnal and semidiurnal Fourier components were used to compute idealized current ellipses for the two frequencies, and the phase differences between the Fourier components of the current and the corresponding Fourier components of the sea level were also determined.

The tentative results of this study are as follows for the Hawaiian Islands: (1) the diurnal tide approaches the islands from a northeasterly direction; (2) the semidiurnal tide from a southwesterly direction. The general flow pattern of the tidal currents between the islands can be determined with a fair degree of accuracy; at certain times, however, the pattern seems to be widely distorted, probably by superimposed long-period currents (perhaps eddies caused by the North Equatorial current).

The results for Palmyra are inconclusive, probably because various diurnal and semidiurnal tidal waves, from different directions, arrive with slightly different frequencies at Palmyra. The available time series are too short to permit discrimination between the various diurnal or semidiurnal constituents, hence the method will give conclusive results only if all major diurnal and all major semidiurnal waves arrive from approximately the same direction.

SUPPORTED BY University of Hawaii

2.0084, USE OF TIDAL POWER AND OTHER OCEAN ENERGY SOURCES

R.H. CHARLIER, Northeastern Ill. State Coll., Graduate School, *Chicago, Illinois* 60625

Survey all likeable sites for harnessing tidal power. Establish feasibility (engineering, financial costs, productivity, inclusion in national grid, consumers market) of various geographical locations. Examine potential of other energy sources from ocean.

Compile comprehensive bibliography, with abstracts, of publications dealing with the tapping of energy resources from the ocean.

*Only support received was a French Francs $500 grant for library research from the Institut Oceanographique de Monaco (J. Y. Cousteau, Director) in May 1968.

SUPPORTED BY No Formal Support Reported

2.0085, LONG-PERIOD WAVES

H.M. STOMMEL, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139 (NONR)

This is a field operation to be carried out near Bermuda. Using newly available differential pressure sensing devices mounted on bottom, it is expected that instantaneous sea level will be resolvable to better than one centimeter at depths exceeding 3000 meters. Bottom-mounting of arrays in relatively shallow water should yield spatial information about propagating periodic surface disturbances of periods less than the semi-diurnal tidal period. Statistical techniques should permit amplitude resolution to better than one millimeter. Immediate goals include in-house sensor evaluation, development of suitable control and recording equipment, packaging, and field testing.

Understanding, based on field measurements, of the spatial distribution and frequency of occurrence of propagating long-period surface fluctuations is fundamental to our knowledge of variability in the ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0086, GREAT LAKES RESEARCH - WATER-LEVEL DISTURBANCES

J.G. HOUSLEY, U.S. Army, Lake Survey, *Detroit, Michigan* 48226

Water-level disturbances are caused by various forces, including astronomical tides, wind tides, surges, and seiches. Research investigates the formation of these water-level disturbances, their patterns and distribution over the lakes, and their effects on water levels in harbors and in rivers. The derived mathematical models of water motion and its relationship with causative forces are used to develop methods of forecasting dangerous long-period waves and currents, and changes in depths and quantities of water.

A set of 16 water-level recorders was in operation on Lake Michigan in 1964. The data have been reduced, and spectral analysis is in progress. Data from 22 water-level gages in Lake Erie will be used to investigate three-dimensional oscillations of Lake Erie in FY 69.

A contract for theoretical investigation of three-dimensional seiches in Lake Erie is in progress.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0087, TIDAL FLOWS IN RIVERS AND HARBORS

J.B. TIFFANY, U.S. Army, Waterways Experiment Sta. , *Vicksburg, Mississippi*
SCHULTZ

The committee known as the Committee on Tidal Hydraulic has been established consisting of civilian employees in various Corps of Engineers Division Offices, District offices, and laboratories who are familiar with tidal theories and tidal problems. The objectives of the Committee are to recommend programs of study, investigation, and research designed to provide the knowledge necessary to arrive at adequate solutions for the engineering problems associated with tidal phenomena, and to render such consultations and advice on specific problems in tidal waterways as may be requested by various offices of the Corps of Engineers.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0088, TIDAL DISCHARGE RESEARCH, NEW JERSEY

A.C. LENDO, U.S. Dept. of Interior, Water Resources Division, *Trenton, New Jersey*

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of New Jersey, the Corps of Engineers, and the Federal Water Pollution Control Administration.

Purpose: To develop and improve techniques for the collection of tidal stage, discharge, quality of water, and sediment data.

Methods: Synchronous records of tidal stage have been collected by digital recorders at estuary stations, computer programs are used to compile these records. Discharge equations have also been programmed and calibration has been based on observed discharge by diographs and other parameters by field measurement. Suspendednsediment, particle- size, and other water-quality information is collected during discharge calibration measurements to define changes during tidal cycles.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey
New Jersey State Government
U.S. Dept. of Defense - Army
U.S. Dept. of Interior - F. Water Pol. Ctl

2.0089, DETERMINATION OF TIDES IN THE REAL OCEANS

C.L. PEKERIS, Amer. Comm. For Weizmann Inst. , *New York, New York*

The Laplace tidal equations will be solved for the semidurnal M2 tide in the real world oceans. Account will be taken of the real coastline and of the variable depth in the real world oceans. This work will be preceded by numerical solutions for the tides in simplified models of world oceans. Computational grids down to 1 degree in size will be used.

SUPPORTED BY U.S. National Science Foundation

2.0090, THEORETICAL STUDY OF OCEAN TIDES FOR PURPOSES OF WORLDWIDE PREDICTION

C.L. PEKERIS, Amer. Comm. For Weizmann Inst. , *New York, New York* (N00014-66-C0080)

Objective: It is important that the Navy be able to predict tides on a worldwide basis, not only in the deep sea but near shore as well, since tidal oscillations affect Naval operations. This research is aimed at a numerical solution of the Laplace equation describing tidal motion for the purpose of predicting tides anywhere in the world.

Approach: The solution of this problem was described by the late Dr. John Von Neumann as the greatest challenge for applied mathematicians in our generation. The solution is being obtained by a numerical process using a large digital computer. The effect of the main lunar or M2 tide is currently under study. Outlines of the world's oceans are being approximated in 1 degree segments. Average ocean depths over 1 degree grid squares are included. As the technique improves more complex conditions are being introduced. For example, water depths over continental shelves are being more accurately described; enclosed water masses such as the Mediterranean will be introduced; more accurate friction laws and even the yielding of the solid earth will be included.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0091, THE OPTICAL PROPERTIES OF SEA WATER AND THEIR USE IN OCEANOGRAPHIC RESEARCH & DEVELOPMENT

G. BEARDSLEY, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Objective. The effective use of all optical instrument systems, including the human eye, within the marine environment requires a knowledge of the optical properties of sea water and an understanding of how, where, and to what extent variations in these properties will affect system performance. In support of this requirement, this research is investigating both theoretically and experimentally the optical properties of sea water, their variability and the resultant effects on artificial and natural underwater light fields. As a part of this, the interrelationships between optical properties and other physical oceanographic parameters such as salinity, temperature, and suspended particles are being studied with the view of developing and applying new optical techniques to water mass identification and delineation.

Approach. This research involves coordinated field observations, laboratory measurements, and theoretical analysis of the scattering and absorption of light by dissolved and suspended material in sea water. Theoretical models of light fields in sea water are being refined as new data becomes available from field and laboratory measurements. Continuing optical scattering measurements on normal hydrographic cruises off of Newport, Oregon, are presently being used to study local and seasonal variations in optical properties. These data will provide the basis for investigating correlations between fluctuations in scattering and the seasonal variability of the oceanographic environment off the coast of Oregon.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0092, DIRECT AND INDIRECT DETERMINATION OF OCEANIC WATER MASS MOTION ON ALL SCALES

J. PATTULLO, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Objective: The efficiency of search and rescue, underwater construction and other operations can be strongly influenced by the character and motion of water masses in the operating area. This research seeks to know and understand water mass movements in the ocean from small-scale and short-lived turbulence to large-scale and steady- state ocean currents in the NE Pacific. Such knowledge and understanding is an important step (i) in learning to predict conditions at a given time and place, and (ii) in the future development of new operational systems, vehicles, or platforms.

Approach: Ships and buoys will be used to continue a detailed description of temperature, salinity, and current conditions and their variations with time off the NW coast of the U. S. Current measurements will be obtained from bottom moored current meters, from dye diffusion field experiments, and from tracking drogues which drift with the currents. The collection and analysis of these data will be improved by the development of an increased hydrographic capability and by the use of modern techniques of signal analysis and statistics. In addition, free-diving deep current meters and a newly designed spar buoy for collecting marine meteorological data will be developed and tested.

SUPPORTED BY U.S. Dept. of Defense - Navy

2E. WAVE DYNAMICS

2.0093, DYNAMICS OF INTERNAL WAVES AND TURBULENCE IN THE THERMOCLINE

G.M. CORCOS, Univ. of California, School of Engineering, *Berkeley, California* 94720

To elucidate the dynamics of the processes in the ocean which result in the transfer of the energy originating in larger scale motion to smaller scale agitation and which intensify and propagate vertically the gradients of salinity and of density found in thermoclines.

Propose to start with the study of elementary flows related to these processes and to carry out these studies by creating stratified flows in a heated tunnel.

A satisfactory scheme for producing a density stratification qualitatively typical of a thermocline and a shear distribution typical of a shear zone between two currents on either side of thermocline has been devised for which the Richardson number range is appropriate for the study of infinitesimal and finite instabilities.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

2.0094, WATER WAVE DOCUMENTATION

J.E. MCNIEL, General Motors Corporation, *Goleta, California* 93017

This contract requires AC-DRL to perform oceanographic research tasks as specified. The AEC sent to AC-DRL in FY 1968 45 Data Logging Systems (individual units for measuring wave heights) with their associated computer and data reduction system for overhaul, storage and maintenance. At some future time AC-DRL may be called upon to emplace these units at various Pacific Ocean locations and to operate the data recording network. In April and May 1968 12 of these units were emplaced off Catalina Island as a practise operation. In June several practise emplantments of the large buoy and anchor were made from a Navy ship in 4000 feet of water using special launching gear developed at AC-DRL.

SUPPORTED BY U.S. Atomic Energy Commission

2. WATER MOTION

2.0095, GENERATION, PROPAGATION, AND COASTAL EFFECTS OF TSUNAMIS

V.A. VANONI, Calif. Inst. of Technology, Graduate School, *Pasadena, California* 91109

This research will be concerned with the experimental and theoretical study of the generation, propagation, amplification of tsunamis (earthquake generated sea waves) and resulting effects on the coastline. The program will involve theoretical and experimental studies which will be concurrent and lend support to each other. Specific areas to be initially examined are:

Experimental - (a) The propagation of tsunamis and the resultant run-up on beaches of small slope and on shore-structures with steep faces. (b) The transient response of harbors to tsunamis.

Theoretical - (a) Generation of tsunamis due to displacements of the ocean bottom for several typical modes of the bottom motion. (b) Propagation of two- and three-dimensional tsunamis through an ocean of arbitrary bottom configuration. (c) Steepening of waves in water of decreasing depth and width variations, including the final stage of run-up on beaches. (d) The wave forces experienced by bodies of simple shapes, both floating and submerged, as well as fixed obstacles.

SUPPORTED BY U.S. National Science Foundation

2.0096, INTERNAL WAVE RESEARCH

O.S. LEE, U.S. Navy, Undersea Warfare Center, *San Diego, California* 92140

Objective: To determine those environmental factors affecting the acoustical uses of the ocean; to observe, define and develope theory to predict the effects of variability in properties of the surface layers affecting sound speed, water motion (orbital, tidal turbulence, internal waves) and other dynamic processes; to investigate experimental developments and theory of internal waves in the ocean.

Approach: Make current reviews of progress in internal wave research; establish criteria for experimentation and analyze data in the light of wave theory and plausible models of the medium; record time-series observations at fixed points in space and at different geographical locations by use of a retrieveable buoyed data system; invite capable scientists to participate in analyses of data.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0097, WAVES

W. KRAUSS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (NONR)

This investigation is intended to study the nonlinear interaction of surface and internal waves and the effect of this process upon oceanic temperature structure. An experiment is to be undertaken to verify a previously developed theory of nonlinear interaction. A theoretical study also is to be undertaken to explain the existence of domes observed in isothermal surfaces by thermistor chain data in the North Pacific.

This is part of the Navy's oceanography program aimed at obtaining fundamental knowledge of the oceanic environment for the needs of naval forces and should provide information that will contribute to the development of thermal structure and environmental forecasts.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0098, WAVE AND SURGE ACTION STUDY FOR LOS ANGELES-LONG BEACH HARBORS

B.W. WILSON, Science Engineering Assoc. Inc, *San Marino, California*

This study reviews the phenomenon of surge action in San Pedro Bay, California, and in the basins of Los Angeles and Long Beach Harbors. It considers all observations, measurements and analyses made in previous studies and supplements them with new analyses of both past and recent wave recordings. In general these analyses identify the frequencies and amplitudes of long period wave activity. Ship behavior and surge damage to wharves and shipping are correlated with the disturbances. The natural oscillating characteristics (eigen frequencies and mode shapes) of the continental shelf and oceanic basins offshore, of San Pedro Bay within the break-water and of the harbor basins are determined by solution of hydrodynamic equations for both mathematical and semi-exact numerical models. These procedures are extended to proposed new harbor basins. Necessary requirements of hydraulic models to simulate the conditions are considered. Finally, the report deals with an instrumentation system design for securing additional field data on long wave heights and currents throughout the harbors.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0099, INTERNAL WAVE STUDY

C.A. GRISCOM, General Dynamics Corporation, *Groton, Connecticut*

This empirical study will investigate the relationships between internal waves and tidal motions over a continental shelf and the relationship of such motions to the temperature structure. Analyses will be made of existing data from an area southeast of Long Island collected by NavOceanO in 1959 and 1960. This work is expected to yield information on: (1) tidal motions and non-tidal drift at Texas Tower NO. 4: (2) tidal phase lag between Texas Tower No. inshore station, the Scotland Lightship, and (3) relationship between state of tide and variance (including internal wave effects) in the temperature structure observed at Texas Tower No. 4.

The results from this study should contribute to the understanding of tidal and internal wave influences upon the thermal structure and, in turn, sound conditions in shelf areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0100, MECHANICS OF WAVE ACTION IN DEEP AND SHALLOW WATER

T. SAVILLE, U.S. Army, Coastal Engin. Res. Center, *Washington, District of Columbia* 20016

Studies are made in both laboratory and field to determine the characteristics of all types of waves (tsunamis, standing waves, harbor surges, etc., as well as normal ocean gravity waves), and the change in these characteristics as the waves approach shore over a shoaling bottom of varied characteristics, and finally break. Study also involves such phenomena as wave set-up and longshore currents which are generated by wave action. The mechanics and kinematics of these waves are also studied. Breakers and surf, and the reforming of waves after breaking are included in this study.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0101, WAVE RECORDING AND ANALYSIS

T. SAVILLE, U.S. Army, Coastal Engin. Res. Center, *Washington, District of Columbia* 20016

A cooperative surf observation program with U. S. Coast Guard collects visual data on surf height, period, direction, and type of breaker at 16 U. S. Coast Guard stations. Statistical compilation is planned.

Recorded wave data are also collected at a number of locations along U. S. Coasts, and an automated system is under development.

Work is on a wave direction gage using a rotating sonic current meter as the indicator and a damped Rayleigh disc is underway.

Pressure records are also planned for obtention at a station at 70' and 35' depths directly under the present relay type gage to obtain data on changes in pressure as related to the depth of the gage and period of the waves.

Standardized analytical methods for engineering use are being developed. New types of gages (such as radar, sonar, and laser) are being studied.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0102, FUNDAMENTAL PROBLEMS IN HYDRODYNAMICS

G. KULIN, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

To conduct investigations on problems such as (1) Internal waves produced by a body of revolution moving in density-stratified liquid to a source or sink impulse; (2) Interaction between long waves and superposed short waves; (3) Damping of shallow-water waves--summary of available information; and (4) Mixing effect of raindrop impingement on a water surface. Problems (1), (2) and (4) are primarily experimental.

Quantitative information on problem (3) already exists but there is considerable need for collection, re-analysis and re-evaluation. Problem (1) has specific application to underwater ordnance and atmospheric waves; problems (2) and (3) can be applied to wave ans surf forecasts; and problem (4) is useful in several areas, particularly reservoir hydraulics. This project continues NBS work on the development and application of various measurement techniques to the solution of important hydrodynamic problems.

Problem (1) involves the measurement of internal waves generated by moving bodies and other impulses. Additionally, it is necessary to develop the corresponding theory, which has proved difficult, particularly in the case of problem (1). In problem (2), theory is available in the literature, but measurements on complex-wave behavior under controlled conditions have never been made. Problem (3) involves extensive literature search and information evaluation, while problem (4) will involve primarily photographic observations along with some analytical treatment.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

2.0103, WAVE GENERATION
P.S. DELEONIBUS, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objective: To construct a turbulent wind wave generation model based on simultaneous measurements of surface shearing stresses and the directional wave spectrum. Such simultaneous measurements will attempt to provide experimental background required to reconcile proposed wave generation theories with observed turbulent transfer of momentum.

Approach: Surface shearing stresses and wind profiles will be measured from an outrigged probe at Argus Island Tower by 'eddy correlation' and will be augmented by an AGOR ship estimating stress downwind from the tower by 'dissipation' techniques. Directional wave spectra will be recovered from surface wave profile data obtained by 'star flight' patterns flown over the sea surface using an airborne wave profiling device. All three component measurements will be made simultaneously during steady state, high wave conditions, preferably after the passage of a well-developed cold front. Wind stress estimates through 'dissipation' will be used during BOMEX.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0104, NUMERICAL WAVE PREDICTION
P.S. DELEONIBUS, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objective: Develop deep and shallow water wave models to provide automatic forecasts of wave height and directional spectrum in the North Atlantic, North Pacific and for the South China Sea.

Approach: Recent advances in numerical deep water wave prediction technique indicate a militarily useful extension of these models into shallow water and coastal regions. Two approaches are being developed simultaneously. A linear model developed by NYU and a non-linear model which employs radiative transfer equations are being extended into shallow water. Wave sensors for use aboard ships, aircraft, towers, and in shallow water areas are being developed for use in verifying these models. The sensors and techniques would also be used operationally to input wave data into forecasting models.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0105, OCEAN WIND WAVE GENERATION AND DISSIPATION
T.P. BARNETT, Westinghouse Electric Corp. , *Washington, District of Columbia* (N00014-67-C-0288)

This study is part of a cooperative field experiment to be carried out in the North Sea during August and September of 1968. The groups involved in the experiment include National Institute of Oceanography in England and the Univ. of Kiel, German Sea-Weather Service and German Hydrographic Office in Germany. The experimental goals are to investigate: (1) the growth of wind waves; (2) interaction between wave-atmospheric fields; (3) processes involved in establishing a fully-developed wave spectrum; and (4) the loss of wave energy due to bottom friction. Measurements of atmospheric parameters and two dimensional wave spectra will be made with aid of buoys, ships and bottom-mounted sensors. Specific objectives of this work unit include obtaining measurements of wave spectra for different wind speeds, participation in overall analysis and interpretation, and documentation of the experiment and results.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0106, OCEAN WAVES AND STRUCTURE
R.D. GAUL, Westinghouse Electric Corp. , *Washington, District of Columbia* (N00014-67-C-0288)

This task involves the following investigations: (1) a small field program designed to intercompare ocean wave spectra measured by the ONR telemetering oceanographic buoy and prototype free floating wave meter; (2) analysis of data collected by the principal investigator during the past five years at Texas A&M under ONR contract. Specifically, the data will be analyzed for tidal motions over the continental margin of the Northeast Gulf of Mexico and to determine the characteristics of oceanic stratification from continuous temperature and salinity profiles.

A thorough knowledge of surface waves on the ocean is important to Naval operations. The internal structure of the ocean volume has important implications to the propagation of underwater sound.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0107, WAVE, CURRENT AND STORM SURGE RESPONSE TO EXTREME WIND CONDITIONS
R.G. DEAN, Univ. of Florida, School of Engineering, *Gainesville, Florida* 32601

This research will involve analytical investigations and field measurements to improve the general understanding of effects of extreme wind systems in causing waves, currents and storm surges in the near coastal waters.

The program will include a comparison of measured field quantities with predictions based on realistic numerical models. On the basis of differences between measured and predicted quantities, the relationships governing the generation of waves, currents and storm surges will be refined and re-evaluated by subsequent sets of measurement-prediction tests. Special purpose laboratory investigations may be conducted in an existing wind-wave tank if deemed advisable.

SUPPORTED BY U.S. National Science Foundation

2.0108, LONG PERIOD WAVES
J.A. PURPURA, Univ. of Florida, School of Engineering, *Gainesville, Florida* 32601 (NONR)

The purpose of this study is to investigate the penetration into narrow fjords of long period waves, having periods ranging from minutes to hours. It is a cooperative program with the Icelandic Government, which has installed and maintains sea level recorders in Eyafjordur. A selected set of recorded data is to be examined to determine auto- spectra and cross-spectra and the results interpreted hydrodynamically in terms of reflection, transmission, amplification, etc.

These studies are important to shore installations which are subject to storm tides and waves and to damage from tsunamis. An understanding of the effect of harbor shapes and sizes on altering wave shapes and sizes will help in selecting building sites and in predicting storm damage.

SUPPORTED BY U.S. Dept. of Defense - Navy

2. WATER MOTION

2.0109, WAVE MEASUREMENT IN THE OPEN OCEAN

K. WARSH, Florida State University, Graduate School, *Tallahassee, Florida* 32306

Measurement, digitization and magnetic recording of a directional wave spectra in the open ocean from a spar buoy by means of resistance wave wires and accelerometers. The same buoy is also used to measure, digitize and record wind profiles.

SUPPORTED BY Florida State University
U.S. Dept. of Commerce - E.S.S.A.

2.0110, AN ANALYTICAL AND EXPERIMENTAL STUDY OF BED FORMS UNDER WATER WAVES

M.R. CARSTENS, Georgia Inst. of Technology, School of Engineering, *Atlanta, Georgia* 30332

The development of, the geometry of, and the drag exerted by bed forms (dunes) which occur on the sea bed under first-order Stokian waves has been studied experimentally in an oscillatory-flow water tunnel. Three series of runs were performed with a different bed material in each series--0.297 mm glass beads, 0.585 mm Ottawa sand, and 0.185 mm Ottawa sand. Total amplitude of the oscillating water was constant during each run and was varied throughout the range from 0.25 ft. to 3.0 ft. for each series of runs. A final report for Contract DA-49-055-CIVENG-65-1 (Georgia Institute of Technology) was issued in September 1967. Publication as a Technical Memorandum of the Coastal Engineering Research Center, U. S. Army Corps of Engineers is pending.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0111, TSUNAMI RUNUP EXPERIMENTS ON A SCALE MODEL OF OAHU

W.M. ADAMS, Univ. of Hawaii, Hawaii Inst. of Geophysics, *Honolulu, Hawaii* 96822

This research will experimentally determine the relationship between wave height and ramp at the shore to save heights at distances offshore for the entire island periphery under different tsunami approach directions. This data will be compared to theoretical predictions and past records to develop a more accurate forecast system thus ensuring more positive cooperation of the public with authorities in the event of major tsunamis.

SUPPORTED BY U.S. National Science Foundation

2.0112, MEASUREMENT OF SURGING IN KUHIO BAY, HILO HAWAII

W.M. ADAMS, Univ. of Hawaii, Hawaii Inst. of Geophysics, *Honolulu, Hawaii* 96822

Pressure gages have been installed at a depth of about 20 feet on pilings of the piers 1 and 2 adjacent to the turning basin in Kuhio Bay. The purpose of this field instrumentation is to permit measurement of the pressure waves for estimating the water motion in the period ranges 8 to 30 second for one gage on pier 2 and period range 3 seconds to 2 minutes at 2 gages under pier 1. These pressure recordings are only made during periods of surging and occasional background control time intervals. Recording is for 12 hour duration on a digital tape transport and, for the high frequency trace, reel time analog chart. The digital records are filtered and played back on a computer facility using IBM 7040, IBM 360 model 50, and IBM 1401. The results of the filtered digital material and analog presentation on a calcomp plotter.

These data are supplied to the Army Corps of Engineers.

Conjunctive study has developed the procedure which predicts the occurance of surge, as defined by historical notes of the harbor master, and is based on correlation of the harbor master records with meteorological weather maps.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0113, HIGH FREQUENCY WAVES

L.F. MCGOLDRICK, Univ. of Chicago, Graduate School, *Chicago, Illinois* 60637 (N00014-67-A-0285-0002)

This project is concerned with theoretical and experimental investigations of phenomena associated with high frequency (large wave number) random wave spectra. The work is concentrated on (a) wave spectra at high frequencies; (b) interaction between surface waves and turbulence in the water itself; (c) resonant surface wave interactions resulting in energy transfer; and (d) development and refinement of wave measuring apparatus. During the coming year, experimental measurements of resonant interactions are expected to be completed and spectral measurements of a random high frequency wave system are to be made.

This project is part fo the Navy's broad program in oceanography being supported to better understand its operating environment. Knowledge from this project should aid the development of better wave forecasting methods required to support a variety of fleet operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0114, AIR/SEA INTERACTION STUDY

B. KINSMAN, Johns Hopkins University, Graduate School, *Baltimore, Maryland* 21218 (NONR)

Research under this task concerns: (1) the generation and growth of wind waves; (b) the interaction of opposing wind waves and swell; (c) convective effects of wave spectrum transformation; (d) the effect of waves on the near surface, vertical wind profile, and (e) the erosion of the thermocline by motion associated with wind waves. The program during the coming year includes laboratory studies of the processes involved in energy and momentum transfer to short surface waves and the detailed nature of entrainment processes in the turbulent mix layer of the oceans; it also includes the development of instrumentation and data analyses techniques for use in field programs on the study of wind wave generation.

Knowledge of the mechanism of wave generation would permit computation of two dimensional spectra of short crested seas. Forecasting of mixed layer depth would be helped by understanding the mechanisms of thermocline formation.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0115, OCEANIC INTERNAL MOTIONS AFFECTING OPERATIONS

C.I. WUNSCH, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139 (NONR)

This task is directed toward understanding density variations in the oceans and the subsequent effect of those variations on operations. In addition to the benefits derived from a better understanding of effects of internal waves, this work should provide engineering knowledge of motions of deep-sea cable arrays. Such information has direct applicability to many naval missions involving long-term deployment of buoyed cables.

This is principally a field experiment designed to sense and record internal waves in order to obtain a better understanding of the role played by these waves in ocean variability. A fixed horizontal cable array will be deployed at mid-depth near Bermuda. Cable motions will be measured, analyzed, and compared with simulated cable motions obtained by numerical modeling. From this cable, time series measurements of temperature will be made using thermistors; supplementary velocity measurements will be made with internally recording current meters suspended from taut-wire buoy systems. The data will provide a first step in measuring directly the horizontal coherence, directionality and spectral distribution of internal waves. Supporting engineering studies and modeling of internal waves will be carried out.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0116, ISLAND-CURRENT INTERACTIONS

C.I. WUNSCH, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139 (NONR)

This is a study of large-scale steady or periodic motions of the ocean. It will involve use of the large rotating tank at WHOI for experimental work and the analysis of existing observational field data. Specifically, this study is intended to try to understand the interaction of an island with its environment. The field of motion around an isolated oceanic island is an extremely complicated function of time undergoing large-amplitude time variations on many scales. The first effort will be to understand how typical of mid-oceanic conditions are those in the vicinity of an island.

This study is intended to gain an understanding of the changes of oceanic structure due to islands, which are, of course, prime operational sites. Such understanding might aid in prediction of the sound propagation field as well as the time changes of major currents in the vicinity of islands.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0117, PROPAGATION AND REFRACTION OF OCEAN WAVES IN NEAR SHORE REGIONS

S.J. JACOBS, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan* (NONR)

Objective: Predictions of ocean wave conditions are needed by naval forces in the conduct of logistics and salvage and rescue operations in nearshore regions. This theoretical investigation of the study of ocean wave propagation in water of variable depth should further the present knowledge of the modification of ocean waves as they progress from deep water to the shore. Such knowledge should contribute particularly to the improvement of methods for predicting wave conditions in the nearshore regions.

Approach: Mathematical methods will be employed to develop theories to explain the propagation of finite amplitude waves in water of variable depth and also provide a means for calculating the height of waves at any given location and time. A non-linear ray theory is to be synyhesized from an improved version of ray theory for variable depth effects and from non-linear mechanics methods used for determining finite amplitude effects. The analytical work is to be supplemented by numerical calculations.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0118, GREAT LAKES RESEARCH - LAKE WAVES

J.G. HOUSLEY, U.S. Army, Lake Survey, *Detroit, Michigan* 48226

The generation, propagation, and decay of waves in the Great Lakes are being investigated and correlated with wind speed and resulting wind stress, wind direction, and lake geometry. The characteristics of waves, including the expected maximum height given locations, will be established; wave climate charts will be prepared; and wave hindcasting methods developed.

Deep-water wave characteristics are being measured at five locations: Eagle Harbor and Whitefish Point on Lake Superior, Point Betsie and Muskegon on Lake Michigan, and Dunkirk on Lake Erie. This program was started in 1964 and will continue through 1971, with subsequent analysis of data.

In FY 69, shallow-water wave characteristics will also be measured at Knife River Harbor, Lake Superior, and Lorain, Lake Erie.

Techniques for wave hindcasting are being developed under contract with the University of Michigan. A report 'Wave Hindcasts vs Recorded Waves' by S. J. Jacobs was published in June 1965; 'Wave Hindcasts vs Recorded Waves Supplement No. 1' by A. L. Cole was published in May 1967. A second contract to apply the developed techniques to the hindcast of waves for Lakes Superior and Huron is in progress.

A contract to develop a sonic wave sensor will be undertaken.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0119, NEARSHORE WAVE THEORY

W.J. HINSE, Michigan State University, Graduate School, *East Lansing, Michigan* 48824

Nearshore wave and current energy budgets will be studied through analysis of field measurements and wave tank observations, and construction of theoretical models to express energy transport, flux and dissipation. Field measurements include wave phase velocity, wave angle, longshore energy and mass transport, current profile and sediment movement. These data will be used to test and improve formulas expressing energy conditions and resultant coastal morphology and dynamics.

A better understanding of energy regimes and correlated changes in shore conditions will improve the reliability of predictions of coastal environmental properties.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0120, WHITECAPPING

E.C. MONAHAN, Hobart & William Smith College, Graduate School, *Geneva, New York* 14456

The purpose of this study is to investigate the onset of whitecapping as a function of wind speed, atmospheric stability, and water temperature and determine the growth rate of whitecap concentration as a function of these parameters. During the coming year, an observational program of whitecaps will be conducted in the North Atlantic from research vessels and fixed platforms. The reduction of whitecap photographs and their analysis with respect to observed meteorological conditions is to be undertaken. A laboratory tank experiment simulating salt water whitecaps is to be undertaken to compare salt water and fresh water characteristics.

Knowledge from this basic study of the air-sea interface is expected to further the understanding of the transfer of energy and matter across the interface and also further the development of wave forecasting for a variety of operational needs.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0121, HIGH FREQUENCY OCEAN WAVES

W. MARKS, Oceanics Incorporated, *Hicksville - Plainview, New York* 11803 (NONR)

High frequency wind generated ocean waves are being studied with respect to their role in the generation of wind waves and also radar backscatter characteristics of the sea surface. Their directional spectra are being derived from stereophotographs and correlations are being established between statistics of these waves and of the radar sea return recorded simultaneously by aircraft.

The results from this task should contribute to the improvement of operational wave forecasts.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0122, THEORETICAL STUDIES OF TSUNAMI PROPAGATION

A. CLARK, Univ. of Rochester, School of Engineering, *Rochester, New York* 14627

The object of the work is to learn more about the effects of variable ocean depth on the propagation of tsunamis. The plan of procedure includes a two-fold theoretical attack on the problem: (i) the development and application of a valid statistical theory, and (ii) the detailed calculation of individual scattering events for certain simple bottom topographies. The ultimate aim of much tsunami work is to increase predictive capabilities, especially with regard to wave amplitudes. From this point of view, the significance of the present work would lie in its contribution to an understanding of diffraction of wave energy due to variable depth. The work may also have significance from the point of view of random wave theory, since it appears that present statistical theories will have to be improved if they are to cover the range of parameters of interest in the tsunami problem.

SUPPORTED BY U.S. National Science Foundation

2.0123, EXPERIMENTAL STUDY OF THE INTERRELATIONS BETWEEN WIND-WAVE PROPERTIES

G.F. BEARDSLEY, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

A preliminary investigation of the relative importance of turbulence and wave motion as mixing agents will be made in the upper ocean. A secondary outcome of this program will result from the simultaneous measurement of the pressure and velocity fields under a random sea. From these data it is hoped to determine the degree to which these fields and their statistics can be calculated using a knowledge of the surface wave height and linear and second order wave theory.

SUPPORTED BY U.S. National Science Foundation

2. WATER MOTION

2.0124, AN OPTICAL METHOD OF MEASURING THE FORM OF THE FREE SURFACE OF A FLUID

H. SCHENCK, Univ. of Rhode Island, School of Engineering, *Kingston, Rhode Island* 02881

This research will deal with the development of a method of studying the speed, form, and character of waves and other disturbances on the surface of a fluid by detecting the angle of refraction of a collimated beam of light at the surface using one or more submerged photocells. It is anitcipated that the developed method will have applications in many areas of fluid science including; physical oceanography, theoretical hydrodynamics, ship model testing, stream and river morphology, and other related fields. The theoretical basis for the method is discussed in a July 1957 Optical Society of America Journal, 'On the Focusing of Sunlight by Ocean Waves.'

SUPPORTED BY U.S. National Science Foundation

2.0125, FIELD DETECTION AND MEASUREMENT OF INTERNAL WAVES

M. RATTRAY, Univ. of Washington, Graduate School, *Seattle, Washington* 98122 (NONR)

Objective: In order to predict the propagation of sound in the ocean, the operational Navy has need of quantitative descriptions of physical processes which affect the density distribution and thereby the sound speed distribution. In support of that need, this research has as its scientific goal the fuller understanding of waves (called internal waves) propagating within the ocean which disturb the density distribution. For internal waves generated by tidal forces near the continental shelf edge and propagating out to sea: (1) the distribution of motions (and thus energy) with depth will be measured, and (2) the adequacy of present theories to predict the propagation of internal waves will be tested.

Approach: Using digital computers to simulate the expected behavior of waves within the ocean the site for a field experiment will be selected. At the locations chosen observations of temperature versus depth will be repeated at closely spaced intervals (order of one minute) for a period of about 15 days duration. These data will be stored and analyzed with the aid of electronic computers. Available analyses techniques should enable the investigators to extract from the temperature variations the associated velocity and energy variations.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0126, THEORETICAL ACOUSTIC-GRAVITY WAVE PROPAGATION

D.G. HARKRIDER, Brown University, Graduate School, *Providence, Rhode Island* 02912

Objective: Four research projects will be investigated to understand the propagation of acoustic-gravity waves in the atmosphere. The first project will determine the quantitative relations between over-pressure and yield at various source and detector altitudes. Theoretical barograms in the frequency and time domain for a wide range of source yields for various sources and detector altitudes will be calculated. The second project will evaluate the necessity for a more complicated source by comparing the simple-point source to the observed direct wave at close-in distances to a nuclear explosions. The closed form of the green function will enables one to calculate by fourier synthesis the far field pressure pulse generated by nuclear explosions and the direct wave in the region surrounding the source. The third project will investigate the epicenter displacement hypothesis as a source mechanism for some of the detectable air waves associated with seismic events. Surface sources of this type can be used to model volcanic eruptions and sudden vertical surface motion associated with earthquakes and underground nuclear explosions. The fourth project will make use of the previously developed source excitation theory of acoustic-gravity waves to investigate the generation of sea-waves by atmospheric disturbances and the formation of tsunamis by oceanic earthquakes.

SUPPORTED BY U.S. Dept. of Defense - Air Force

3. METEOROLOGY

(see Also Environmental Prediction, Chapter 4c)

3A. AIR-SEA INTERACTION

(see Also Chapter 2, Water Motion)

3.0001, ANALYSIS OF THE MARINE LAYER - A MESO METEOROLOGICAL STUDY

S.R. FRANK, Aerometric Research Foundation, *Goleta, California*

The project's specific aim is to define and model the Marine Layer of the atmosphere in terms of its diffusion and transport characteristics. In order to do this a systematic network of weather observers has been established in the Santa Barbara Channel Area through the cooperation of Federal, State, and private organizations. Using these observations for basic flow analysis of the area, a program has been established for the determination of heat sources and sinks of the ocean surface. The consideration of surface thermal modification of the overlying Marine Layer plus the distortion of flow due to orographic influences, has resulted in an integrated attack on the problem of potential dispersivity of the atmosphere. The program will involve utilizing a mobile 'turbulence sensor' (a portable tower) with wind and temperature stations, for fine scale determination of turbulence at specific locations during critical meteorological conditions. It is anticipated that use of this 'sensor' will result in quantitative definitions of orographic contributions to turbulence in the Marine Layer.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0002, OCEAN DYNAMICS SEA AIR INTERACTION MODELS-MEDITERRANEAN

T. LAEVASTU, U.S. Navy, Postgraduate School, *Monterey, California* 93941

To determine those environmental factors affecting acoustical uses of the ocean; to categorize strategic areas into similar acoustical provinces; provide a foundation for medium and long range forecasting, incorporating correct sea-air interaction models which emphasize the dynamics of the surface layers.

Study the sea-air exchange in the Mediterranean in relation to changes in the overlying air masses; to improve computation of exchange and establish physically correct numerical feedback models; investigate synoptic and seasonal behavior of oceanic fronts and their temperature and salinity structure; study the possible similarity of Moroccan and California regions, especially with respect to their response to driving forces (surface wind).

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0003, TRANSPORT PROCESSES ACROSS AN AIR-WATER INTERFACE

R.L. STREET, Stanford University, School of Engineering, *Palo Alto - Stanford, California* 94305

The objective of this study is to verify or refute present interface process hypothesis and to discover additional facts about the air-water interface phenomena.

It is proposed to make the following studies: (1) direct measurements of the mass, momentum and energy transfers across an air- water interface; (2) a comparison of measured results with estimates from theoretical and empirical formulae; (3) measurements and analyses of the statistical properties of the fluctuating flow properties in the surface boundary layer; and (4) an attempt to provide new descriptive concepts for the interface transfers as suggested by the above measurements and analyses.

The experimental measurements will be made in the wind, water wave research facility located at Stanford University. The facility is equipped with a centrifugal fan that causes a flow of air over a body of water and a mechanical wave generator.

SUPPORTED BY U.S. National Science Foundation

3.0004, OCEAN WAVES

C.S. COX, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038 (NONR)

This task is concerned both with surface wind waves and with internal waves and associated causes of temperature variations in the ocean. The relationship between eddy stresses in an overlying wind field, the average wind profile, the growth of wind waves and the partition of momentum between waves and currents is being studied in a laboratory wind-wave channel. The study of internal waves concerns the energy distribution according to frequency and also the vertical distribution of this energy. The layered fine scale of temperature structure in the oceans is being examined in order to interpret measurements of temperature fluctuations resulting from internal waves.

Improvements in the theory of wind-wave interaction are expected to contribute to improvements in the prediction of wave conditions. Studies of turbulence (including internal waves) in the ocean contribute directly to understanding time and space variations in sound propagation.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0005, OCEAN-ATMOSPHERE STUDIES WITH STABLE ISOTOPES AND DISSOLVED GASES

H. CRAIG, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

This research will cover the following areas of investigation: (1) The formation and mixing of deep and intermediate water masses, using deuterium, oxygen 18, and dissolved gases as additional oceanographic parameters together with salinity and temperature to characterize water masses and mixing process; (2) The exchange of water between the atmosphere and sea, using the variations in deuterium and oxygen 18 content of atmospheric water vapor and surface seawater over the oceans; (3) Experimental studies of the nature of the air-sea interface, based on equilibrium and kinetic isotopic fractionation effects in the transport and exchange of water across the interface; and (4) The carbon dioxide-dissolved oxygen system in the ocean, using gas chromatography at sea to measure concentrations and using the carbon and oxygen isotope ratios of these components as additional parameters.

SUPPORTED BY U.S. National Science Foundation

3.0006, LARGE-SCALE INTERACTIONS

J. ISAACS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (NONR)

The purpose of this task is to investigate the nature of large-scale variations in oceanographic and meteorological conditions in the North Pacific and the interrelationships of the variations. Deep moored, unmanned instrumented oceanographic and meteorological stations will be used in arrays as the principal means of obtaining the necessary environmental data. During the coming year, two buoy clusters will be deployed north of Hawaii as a pilot study for the larger experiment. The collection and analysis of existing data for the North Pacific will continue and will be used both in the design of the overall experiment and in the interpretation of the resulting data.

Reliable prediction of environmental conditions at sea have long been a necessity for naval operations. The results of this task hold great promise for providing the information and understanding of the environmental processes which control the changes in the oceans. This knowledge is necessary to the reliable prediction systems required.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0007, TOTAL HEAT FLUX MEASUREMENT WITH A TWO-WAVELENGTH RADIOMETER

E.D. MCALISTER, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The objective of this work is to continue an investigation of the total heat flux measurement in the air overlying the ocean surface using a two-wavelength radiometer. It is anticipated that measurements accurate to within 5% of a known heat loss can be accomplished on the open sea.

The study will be divided into three major parts: (1) a laboratory study of factors determining heat flow; (2) a study of the relationship between the heat flow at sea and meteorological elements; and (3) a study of the variations of heat flow.

The laboratory study will establish the accuracy of the two wavelength radiometer (4.45 to 5.1 microns). It will offer a wealth of information upon which can be built an understanding of the mechanisms involved in heat transfer. It is recognized that it will be difficult to correlate the heat flow measurements with meteorological measurements due to the inability to measure meteorological variables accurately over the open sea. The variational studies are aimed at determining differences in surface temperature due to distance from the shoreline and due to the diurnal cycle.

SUPPORTED BY U.S. National Science Foundation

3.0008, WAVE GENERATION BY THE TURBULENT WIND FIELD OVER THE SEA

R.W. BURLING, Univ. of British Columbia, Graduate School, *Vancouver - British Columbia, Canada* (N00014-66-C-0047)

Sea surface conditions induced by local winds affect a variety of naval operations such as replenishment at sea and other operations. The impact of adverse sea conditions upon such operations may be reduced as a result of accurate prior forecasts. The development of a capability to produce accurate predictions requires an understanding of the physical processes involved in the generation of waves by the wind and is being developed under this task.

Approach: A series of field experiments will be conducted from a research platform located in shallow water off Vancouver, British Columbia. These experiments will attempt to determine the characteristics of the turbulent wind field over the sea. The detailed nature of the turbulent field will be examined close to the sea surface using hot wire anemometers and acoustic anemometers. A system for use from open ocean sites also will be constructed for installation on Cobb Seamount and used during the Barbados Oceanographic and Meteorological Experiment. Pressure fluctuations within the atmospheric boundary layer and on the surface of waves also will be measured in relation to wave generation processes and supplement the wind velocity measurements.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0009, ATMOSPHERIC-OCEANIC-GLACIOLOGIC INTERACTIONS IN THE ANTARCTIC

W.S. WEYANT, U.S. Dept. of Commerce, Research Lab. , *Boulder, Colorado* 80302

The Polar Meteorology Group of the Air Resources Laboratory at ESSA will perform researches which are directed at providing a further description and explanation of the physical processes which occur in the Antarctic atmosphere. This will be accomplished through studies of 1) the nature and magnitude of energy and water exchange between the atmosphere and the underlying snow, ice or water surface; 2) the heat and mass budgets of the atmosphere -snow-ocean system which controls the Antarctic heat budget; 3) how the Antarctic heat budget is related to the overall terrestrial heat budget; and 4) the relationship of the general high latitude atmospheric circulation to the total planetary circulation. The data used in these studies will be recovered from the International Antarctic Meteorological Research Center at Melbourne, Victoria, Australia, the National Weather Records Center in Asheville, North Carolina, or direct from the records of any station, ship, or satellite engaged in high southern latitude meteorology.

As time permits special attention may be given to studies of 1) radiation balance and the net vertical and horizontal transport of sensible and latent heat, 2) ozone concentrations and the atmospheric circulation model, 3) circulation at all levels up through the stratosphere, and 4) temperature, humidity and wind profiles in the regions of the Antarctic convergence to learn about the effects of the convergence on the boundary layer of air masses.

SUPPORTED BY U.S. National Science Foundation

3. METEOROLOGY

3.0010, DEVELOPMENT OF PHYSICAL-NUMERICAL MODELS FOR STUDIES OF THE ATMOSPHERE-OCEAN PLANETARY BOUNDARY LAYER

J.P. PANDOLFO, Travelers Research Center Inc. , *Hartford, Connecticut*

The present model represents a complex local theory for the study of the vertical structure, and temporal changes, characteristics of the atmosphere-ocean planetary boundary layer. The combined effects of boundary layer turbulence in stratified (humidity and salinity dependent) flow, advection by the mean velocity, mixing due to wind generated waves on the interface, and cloud-dependent radiative heating, are calculated iteratively in the mixed initial-boundary value problem represented by the model equations.

Experimental objectives during the past year included model evaluation and climatological supplement calculations for a region of the tropical oceans to be intensively observed next year. The model behavior successfully simulates some already measured characteristics of this region. The model also successfully simulates some recently observed general characteristics of this layer.

The models are now being generalized to include investigation of the horizontal structure of the boundary layer on several scales. Future work will make use of the intensive observational data to be obtained next year in these analyses. The series of projects began in FY '66, and is expected to end in FY '71.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0011, MISCELLANEOUS SERVICES FOR FEDERAL AVIATION AGENCY (VISUAL RANGE)

C.A. DOUGLAS, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

To furnish measurement of the characteristics of fogs during the testing of visibility meters. To obtain data on fog variability, air- sea interface, for example. To furnish technical advice and assistance on problems related to the determination of visibility conditions at airports. This is assistance to other agencies utilizing facilities and knowledge not available elsewhere, NBS Mission Component 1.6.

Measurements of fog density and its variation with time and place will be made as required at the NBS Field Laboratory, Arcata, California. Technical advice and assistance will be supplied as requested.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

3.0012, EVAPORATION OF WATER

A. WEXLER, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

The principal objective of this project is to make a study of the feasibility and probable value of performing laboratory or other types of research for investigating the physical processes of evaporation. This project falls within the mission of NBS to conduct research on basic measurement techniques and instrumentation. It should lead to improved methods of measuring water vapor flux and evaporation, which in turn should assist meteorologists and hydrologists in measuring and predicting water losses due to evaporation over land and water.

The study will include a survey of technical literature, visits to laboratory and field facilities where evaporation research is being pursued, development of recommendations for suitable research programs and proposals for equipment and instrumentation.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

3.0013, EXCHANGE METEOROLOGIST WITH JAPANESE ANTARCTIC RESEARCH EXPEDITION

W.S. WEYANT, U.S. Dept. of Commerce, Environ. Sci. Serv. Admin. , *Washington, District of Columbia* 20235

A study of the atmospheric boundary layer over the Antarctic Ocean will be conducted aboard the Japanes icebreaker, Fuji, by Mr. Martin Sponholz, the U.S. Exchange Scientist with the Japanese. The investigations will include (1) an examination of the effect of the Antarctic Convergence and the ocean-sea ice boundary on the overlying atmosphere, and (2) a comparison of the data for the lower 1000 feet of the atmosphere over the ocean, over the sea-ice and along the coast, with similar information obtained inland at Plateau Station (elevation 11,690'). The data will be obtained from sensors suspended from four kytoons towed from the stern of tthe ship. A modified radiosonde will transmit pressure, humidity, wind speed and temperature observations obtained to a height of 1000 feet from the sensors to the ship.

SUPPORTED BY U.S. National Science Foundation

3.0014, RESEARCH AND COMPUTATIONS ON THE THERMODYNAMIC PROPERTIES OF AIR AND RELATED GASES

H.W. WOOLLEY, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

XXA computer program for the NBS UNIVAC for the calculation of thermodynamic properties for a gas mixture such as air or hydrogen with other gases of up to triatomic molecules has been prepared (except for general de-bugging) by modification and merging of two previous 7094 programs. A capability of free energy minimization as composition is changed by chemical reaction is provided. Transport property estimates with Enskog type density corrections can also be made. For polar gas pairs, a collision-integral increment between Lennard-Jones and Stockmayer values is used. Non-polar values are based on the exp- 6 potential with alpha read in or based on the close approach behavior from theory, with the 1, exp-6 potential. The program has provision for up to six terms in a polynomial in the density representing ln(PV/RT) for each of the constituents. The temperature dependence is by series compatible with the Stockmayer potential. The constants required may be obtained via another program under development for fitting isotherm data. It fits second virials with a 1, 12-6 potential and extrapolates to high temperatures with rigid sphere relations for higher virials. Accepted critical constants can be fitted; provision is also made for later use of a singularity function in the critical region to fit liquid-vapor equilibrium data in using the main thermodynamic property program. In the absence of newly fitted PVT constants, it is possible to use old constants such as were used for B and C for some gases in NBS Circular 564 if their densities or mole fractions are low. Inter-ionic effects have been coded for another program and can be added here also. New theoretical estimates for negative ion effects have been derived. Spectroscopic constants for diatomic constituents have been studied with the view of improvement for high temperature calculations. New procedures for theoretical analysis of spectroscopic constants for diatomic molecules have been devised.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

3.0015, BARBADOS OCEANOGRAPHIC AND METEOROLOGICAL EXPERIMENT

R. MORSE, U.S. Dept. of Transportation, Oceanographic Unit, *Washington, District of Columbia*

The Barbados Oceanographic Meteorological Experiment (BOMEX) is a comprehensive synoptic meteorological and air-sea interaction study to be conducted in the vicinity of Barbados Island during the summer of 1969.

Evaluation of momentum transfer, sinks and sources of vapor in the atmospheric system, wind system at sea and measurements of standard oceanographic variables, salinity and temperatures, as a function of depth will be made. The U. S. Coast Guard Cutter ROCKAWAY (WAGO 377) will participate in the program.

Other agencies participating are the Environmental Science Services Administration, Atomic Energy Commission, Bureau of Commercial Fisheries, National Aeronautics and Space Administration, National Center for Atmospheric Research, National Oceanographic Data Center and the National Science Foundation.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

3.0016, AIR-SEA INTERACTION (WAVES)

R.L. SNYDER, Nova University, Graduate School, *Fort Lauderdale, Florida* (N00014-67-A-0386-0001)

This is research into processes of energy exchange between wind and ocean waves. It involves field measurement program at an experimental site in the Bight of Abaco. Three interrelated activities are involved: (1) studies of white caps as a possible mechanism for dissipation of energy put into the sea by wind; (2) measurement of wave induced pressure fluctuations in an effort to explain growth rates of wind waves; and (3) instrumentation of Abaco site for measurements of turbulent fluctuations in the water and interpretation of such measurements.

An improved understanding of wind generation and decay of ocean waves will assist in the development of improved wave forecasting conditions. Improved knowledge of sea state conditions assists many naval operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0017, EXPERIMENTS IN AIR-SEA INTERACTION INVOLVING SURFACE PRESSURE MEASUREMENTS

E.B. KRAUS, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

The objective of this work is to carry out two separate but related experiments using the same location and instrumentation of internal waves in the lower atmosphere and the second deals with the measurement of the geostrophic and actual surface winds as a method of computing the stress at the air-sea interface.

The first experiment is designed to test Bretherton's theroetical concept that wave groups and their propagation can be used to describe gravity waves that travel in the lower atmosphere associated with low level inversions. It is hoped that measurements of travelling perturbations of the surface pressure and the surface wind can be used to express the group velocity and the wave energy of the group. These quantities can be expressed as a function of the absolute frequency, the horizontal wave number components, the wind velocity and the local Brunt-Vaisala frequency. From the mean distributions of wind and temperature from nearby radiosonde stations as well as the records from the array of surface pressure transducers, information about the energy, frequency, and propatation of the wave groups in the atmosphere will be obtained.

The second experiment is designed to clarify the observation that there is a wide divergence between the actual wind and the geostrophic wind near the sea surface. It is hoped that systematic, simultaneous recording of actual and geostrophic surface winds over the water will permit a derivation of a frequency-dependent empirical transfer function between the two vectors.

SUPPORTED BY U.S. National Science Foundation

3.0018, TRITIUM IN HURRICANES

G. OSTLUND, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

The objective of this research is to study the air/sea exchange of water in hurricanes and in the region of the trade winds by measuring the tritium content of the water and water vapor in the oceans, rain, clouds and air. Hurricanes and tropical storms in various stages of development have been studied in an effort to establish a connection between the intensity of air/sea exchange and the development of the tropical disturbance.

It is planned to achieve the above objective by sampling the rain, clouds and air in and around hurricanes. Aircraft from ESSA's Aircraft Flight Facility will be the sensor platforms. Sea water will be sampled by ships and small boats from the Institute of Marine Science. In addition samples of water vapor will be obtained during the non hurricane season in the trade wind flow that moves off the African continent and travels across the Atlantic to the Lesser Antilles. It is hoped that such information might be instructive in studying the modification of the air by the sea. The collection phase will be supported by ESSA.

An emphasis will be made to bring more interested atmospheric scientists into this work to interpret the chemical data collected and analyzed by Dr. Ostlund. This aspect will become a major effort under NSF support. An effort will be made to measure other tracers such as the tritium component in the normally occurring hydrogen gas in the air and develop techniques for instantaneous analysis of the tritium.

SUPPORTED BY U.S. National Science Foundation

3.0019, STUDY ASSOCIATION BETWEEN TRADE WIND SYSTEM AND NORTH PACIFIC OCENAOGRAPHIC CLIMATE

G.R. SECKEL, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Honolulu, Hawaii* 96812

The objective of the investigation is to develop a model for air- sea interactions. The most important of these concerns the linkage between the trade wind system and surface water motion. The Hawaiian oceanographic climate, the seasonal changes in temperature and salinity, are largely determined by changes in the location of the boundaries and changes in the speed of the California Current extension, or, surface water movement. A project to make preliminary investigations concerning surface water motion as reflected by the Hawaiian Oceanographic climate, and associated changes in the trade wind system, are an important part of the initial phase of the experiment.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

3.0020, ATMOSPHERIC TURBULENCE FIELD STUDIES

P. FRENZEN, Argonne National Laboratory, *Argonne - Lemont, Illinois*

The structure of small-scale turbulence in the lowest 10 meters of the atmosphere is being investigated with the object of developing operational methods for the routine measurement of energy exchange at the surface of the earth. Turbulent fluctuations of wind speed and temperature are recorded under conditions in which the vertical flux is invariant with height, using specially developed instruments mounted on portable towers over selected, uniform sites. A recent theoretical method for determining the turbulence dissipation rate (and, subsequently, the vertical flux of momentum) from reductions in variance effected by averaging wind records over succesively larger intervals (Frenzen, Quart. J. Roy. Meteor. Soc., 91 (1965); 28-34) has been verified in the field using data collected by a fast-response wind measuring system constructed for the purpose. A similar theoretical treatment of thermal fluctuations has been prepared (Frenzen, Radiol. Phys. Div. Ann Rep., July '64 - June '65, ANL-7060; Argonne National Lab.; 140-133) and a temperature system designed to utilize this result for the measurement of vertical heat flux is being completed. Because of the relative simplicity of the instrumentation required and an inherent freedom from longer period disturbances such as those caused by waves rocking an instrumented platform, these 'variance reduction' methods appear to be especially suited to the problem of measuring vertical eddy transfer over large bodies of water.

Apparatus is currently being constructed for the direct measurement and computation of vertical fluxes in the field by the eddy-correlation method. Unlike most devices of this kind previously used in micrometeorological investigations, the present equipment will employ digital rather than analogue computation procedures.

SUPPORTED BY U.S. Atomic Energy Commission

3.0021, EXPERIMENTAL FLUID DYNAMICS

A.J. FALLER, Univ. of Maryland, School of Engineering, *College Park, Maryland*

The objective of this proposal is to continue the studies of boundary layer instability in rotating systems, of oscillatory circulations due to the tilt of the rotation axis, of the generation of wind waves, and of the stability of a barotropic geostropic jet on a 'beta' plane. It is further proposed to initiate an experimental study of thermally-driven circulations that are designed to simulate the general circulation of the atmosphere.

The problems will be approached in the following manner: (1) Boundary layer instability and transitions - numerical integrations for combined shear flow and thermal convection will be undertaken. Boundary layers with both stable and unstable stratifications will be studied. (2) Oscillations in a tilted rotating tank -

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the tilted axis will be processed to allow various combinations of tidal and rotation frequencies. Regions of resonance will be investigated theoretically and experimentally. (3) Analogues of the general circulation of the atmosphere - thermally-driven circulations will be generated by heating and cooling a large cylindrical rotating tank. Statistics of the flow will be measured directly. The resulting numerical models will compare statistical features with corresponding statistical measurements of the experiment. (4) Wind-generated waves and small-scale air-sea interactions - studies will include the determination of velocity profiles in both air and water, the turbulence level in air and water and the effects of surface films.

SUPPORTED BY U.S. National Science Foundation

3.0022, DYNAMICS OF AIR-SEA INTERACTION

E.L. MOLLOCHRISTENS, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139

The objective ofthis work is to continue studies of the dynamics of air-sea interaction. The ultimate goal is to obtain quantitative measures of the vertical fluxes of heat, moisture and momentum across the sea surface as a function of time history, scale, and atmospheric and oceanographic parameters. The emphasis will be on understanding the details of the small scale dynamic processes such as the processes of generation of turbulence and the structure of the turbulent field over the sea surface.

Problems related to the small scale processes are being investigated in laboratory experiments. These studies include investigations of stratified shear flow stability and turbulence, the structure of the turbulent Ekman layer, and phenomena involving stratification and rotation.

Field studies are being conducted also so the full scale range of parameters can be obtained as well as the full complexity of the natural processes. These studies include measurements in the boundary layer over the sea surface of the spatial and temporal structure of the velocity and temperature field under known mean conditions of wind profile, temperature profile, current, water temperature structure and surface wave field.

This program is supported jointly by the Office of Naval Research and the National Science Foundation.

SUPPORTED BY U.S. National Science Foundation

3.0023, AIR-SEA INTERACTION

E.L. MOLLOCHRISTENS, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139

This task is concerned with the dynamics of small scale air-sea interaction processes within the boundary layers of the ocean and atmosphere, with particular emphasis on fluctuations in velocity, temperature and salinity to determine the turbulent flux of momentum, salinity and heat throughout the surface layer of the ocean. It is primarily a field program with experiments being conducted from a buoy system set in Buzzards Bay, Massachusetts.

The results from this taks are expected to further our understanding of the environmental processes influencing wave generation and the thermal structure of the oceans. From this understanding may result improved forecasting methodology to support marine operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0024, LARGE-SCALE INERTIAL OCEAN-ATMOSPHERE RELATIONSHIPS

I.I. SCHELL, Ocean Atmosphere Res. Inst. , *Cambridge, Massachusetts* 02138

The objective of the work is to conduct an investigation into the nature of large-scale intertial ocean-atmosphere relationships involving the equatorward extent of ice and the contemporary and subsequent large time-scale monthly and seasonal sea surface temperatures and weather as a basis for possible long-range forecasting.

To accomplish the above objective it is planned to analyze synoptically and statistically the southerly ice limit in the Greenland Sea and the Okhotsk Sea and compare them with charts of sea level and upper level pressure distributions, winds and jet streams, sea temperatures, etc. Indices of circulation are to be developed from an analysis of the correlation of ice limits and sea temperatures with subsequent weather as a basis for long range forecasting of the sea surface temperatures of the northeastern Atlantic and the weather of northwestern Europe as well as the sea surface temperatures of the northwestern Pacific and the weather of northern Japan, the Aleutians and Alaska.

SUPPORTED BY U.S. National Science Foundation

3.0025, INTERACTIONS BETWEEN TURBULENCE, CLOUDS, SEA TEMPERATURE

A.F. BUNKER, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

The objective of the proposed work is to analyze, evaluate and interpret the vast body of meteorological data obtained by the WHOI C-54Q aircraft during the International Indian Ocean Expedition (1963- 65) and the Line Island Experiment (1967).

The Indian Ocean work will include vertical cross sections of clouds collated with streamlines, temperature cross-sections and photographs from satellites and the aircraft. Turbulence and turbulent flux measurements in clear and cloudy air above the frictional level will be studied in detail to find their relation to sea surface temperatures, wind fields and gradients, the conditional instability of the air in the southwest monsoon, the stability of the air in the northeast monsoon, and the convective activity in the equatorial trough.

The Line Islands work will include making cloud cross sections and relating the cloud types and heights to the thermal, water vapor and wind fields of the atmosphere in the equatorial region. Turbulence measurements and turbulent flux computations made in the moist layer between 6 degrees S and 21 degrees N will be studied to determine their relation to the sea-surface temperature and the thermal and kinetic fields that were observed at the same time.

SUPPORTED BY U.S. National Science Foundation

3.0026, AIR-SEA EXCHANGE

P. SAUNDERS, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

The objectives of this investigation are to improve our knowledge and understanding of the short wave isolation reaching the surface layers of the ocean and to improve the accuracy and usefulness of measurements of sea surface temperature using remote techniques. The relationship between bulk water and interface temperatures and the exchange of energy and momentum from air to sea is to be examined by observations obtained from a tower in Buzzards Bay. Measurements also are to be made of the albedo of the ocean for both diffuse and direct insolation, and the apparent surface temperature observed from infrared radiation measurements is being examined as a function of the height of the sensor.

The results from this work are expected to provide basic understanding of the radiative processes which heat and cool the surface layers of the oceans, thereby affecting the thermal and sound velocity structures. Such knowledge is required to develop meaningful models from which forecasting methods can be developed.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.027, TURBULENCE OVER WAVES

D.J. PORTMAN, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan* (N00014-67-A-0180-0005)

The objective of this task is to investigate the structure of turbulence and of the turbulent fluxes of momentum and heat in the atmospheric boundary layer immediately over the sea surface. An experimental investigation will be made of the three-dimensional structure of turbulence and of the spectral characteristics of temperature fluctuations. Analyses will include determination of the Reynold's fluxes of heat and momentum over water waves. Measurements will be made from a fixed tower or buoy and also a low-flying aircraft.

The results from this task are expected to contribute to the understanding of the nature of the wind field immediately above the sea surface. Better knowledge of its characteristics are needed to improve wave forecasts for naval operations and to assist aircraft operations at low altitudes and landings at sea. Improved understanding of heat flux should aid in improving forecasts of thermal structure as well as meteorological forecasts over oceanic areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0028, AIR-SEA INTERACTION PROCESS

A.C. WIINNIELSEN, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan*

Since the wind is the chief driving force of the lake, specification of the wind in the layer of air just above the water surface is of fundamental importance. To obtain wind fields over the lake on a routine basis, parameters must be chosen which a) are themselves routinely available, b) uniquely define the wind profile near the surface or the wind at some significant level and c) are representatives of large portions of the lake.

On the other side of the air-lake interface the problem of specifying the possible modes of response of the Lake arises. To provide information of water flow a relatively dense network of instrument buoys was placed in Lakes Michigan, Ontario and Erie by the Great Lakes-Illinois River Basins Project of the Division of Water Supply and Pollution Control, U.S. Public Health Service.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0029, GREAT LAKES RESEARCH - ENERGY TRANSFER AT THE AIR-WATER INTERFACE

J.G. HOUSLEY, U.S. Army, Lake Survey, *Detroit, Michigan* 48226

The direct contact between water and air at their interface produces an exchange of energy and mass. Analysis of the interface activity will establish the mechanism by which energy and mass transfers, both air to water and water to air, are accomplished. These transfers are in the form of heat energy, such as radiation, conduction, convection, condensation, and evapaoration; kinetic energy as in wind tides and waves; mass as in absorption of gases and soldis by water; and electic charge transfer. Results will lead to improved methods of predicting waves, currents, wind tides, water supply, and modification of regional climate by the lakes.

Under contract with the University of Michigan, data are being obtained at an instrumented tower about one mile offshore, near Muskegon in Lake Michigan. The tower was in operation for the seasons 1963, 1964, and 1965, and 1967. Reduction and analysis of the data will continue in FY 69; the instrumented tower was reestablished in May 1968. Development of equipment for wind-stress measurements on a continuous basis is underway.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0030, SURFACE TENSION

J.J. JASPER, Wayne State University, Graduate School, *Detroit, Michigan* 48202

The data on surface tension of pure liquids at ordinary temperatures will be compiled from the literature and critically evaluated. The surface tensions of liquids are needed for an understanding of all processes of liquid-liquid extraction, wetting of solids, adhesion and many meteorological processes. This project is in accord with the reference data mission of NBS.

Data on the surface tension of liquids at ordinary temperatures will be compiled from the literature and evaluated as to quality and presented in various useful ways.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

3.0031, PROJECT EVAPORATION

C.C. EASTERBROOK, Cornell Aeronautical Lab. Inc. , *Buffalo, New York* 14221

The main objective of this project is to determine the effect of wave action on the rate of evaporation from a free water surface. Experiments carried out in an enclosed wave-tank as part of the initial contract showed that evaporation was actually reduced from 30% to 40% by well developed waves on the surface. Subsequent study of air flow over the waves indicated that this flow is modified in such a way as to retard the upward transport of water vapor.

The extension to the evaporation project carried the study into the real world where measurements were made in the free atmosphere over the surface of Lake Hefner in Oklahoma. This data was recorded on magnetic tape by a cooperating group from ESSA in Boulder, Colorado. The data is currently being analyzed and results will be reported in the final report.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

3.0032, RADIANT ENERGY FLUX ACROSS THE AIR-SEA INTERFACE AND HEAT BUDGET OF THE OCEANS

R. HOLLMAN, New York University, School of Engineering, *New York, New York* 10003 (NONR)

Objective: The needs for environmental predictions of ocean thermal structure require knowledge of the factors controlling the heat budget of the surface layers of the ocean. The heat budget is controlled by radiation directly from the sun and indirectly from the sky as well as that radiated back to the atmosphere from the oceans. This research on the exchange of radiant energy at the sea surface is aimed to contribute to naval oceanographic forecasting services as well as marine meteorological forecasts.

Approach: The flux of radiant energy at the sea surface is being measured as a function of solar evaluation and cloud conditions in order to determine the coefficient of reflectivity for sky radiation. The results are being used to derive prediction equations for the downward flux density of radiation under varying cloud amounts and types of air-masses. Infrared measurement techniques from spacecraft, aircraft and surface ships also are being studied to determine the reliability to which the longwave back radiation from the sea surface can be determined.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0033, TURBULENT PROCESSES AT AIR-SEA AND BOTTOM BOUNDARIES OF THE OCEAN

A.D. KIRWAN, New York University, School of Engineering, *New York, New York* 10003 (NONR)

Objective: The Navy requires knowledge of turbulent processes in the oceans in order to describe and predict the oceanic environment for the planning and execution of operations. A better understanding of the turbulent regine at the air-sea and bottom boundaries bears upon the prediction of thermal structure ; on bottom currents and their variability affecting deep rescue vehicle operations, mining operations and the determination of loading forces on fixed underwater structures; and on surface wave and wind forecasts affecting the operations of surface ships.

Approach: Both theoretical and field experimental work on turbulence is being conducted. Earlier theoretical work by Eringin is being extended and applied to flow between plates. Field measurements of the structure of turbulence in the lower levels of the atmosphere immediately above the sea surface are being made from ARGUS Island off Burmuda. The effects of sea surface roughness, the fetch of the wind field and the stability of the atmosphere on the transfer of energy from the atmosphere to the ocean is being determined. The program is being conducted jointly with NavOceanO. A paralleling study of the turbulence in the bottom boundary layer of the ocean is being conducted in a tidal channel off Long Island, N. Y., to determine the nature of the velocity field next to the bottom.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0034, PHYSICAL OCEANOGRAPHY

T. ICHIYE, Columbia University, Graduate School, *Palisades, New York* 10964 (N00014-67-A0108-0004)

This task is concerned with air-sea interactions and diffusion processes within the upper ocean, and with the micro-thermohaline structure of the oceans. The relationships between

Langmuir type cellular convection in the surface layer and environmental factors such as surface currents and their shear, winds, and waves, are being investigated. Information on the heat exchange between sea and atmosphere also is being obtained using airborne infrared thermometer and humidity sensors. A joint program with the University of Hawaii using STD's is to be undertaken to determine the horizontal scales of the thermohaline microstructure present in the region of the Pacific immediately north of Hawaii.

Surface layer parameters and the ability to forecast them are important in fleet operations and in the dispersal of waste and contaminants. Oceanic thermal structure and its space and time variations strongly affect acoustic propagation. Naval capabilities in these areas will benefit from the results of this research program.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0035, RESEARCH IN AIR-ENERGY EXCHANGE

W.V. BURT, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

The emphasis to date has been on measurement of radiation; short- wave radiation has been measured at sea and in port. These measurements will be critically examined with future concurrent measurements at the Marine Science Lab and at sea. Equipment is being prepared to separate diffuse from direct short wave radiation at the Marine Science Lab, and a pyranometer has been installed to be used with filters to study the spectral variation of incident solar radiation. An inverted pyrheliometer will be used at sea to measure reflected short wave radiation, and a specially vented radiometer has been built for measurement of long wave radiation at sea.

Heat stored in the waters is under intensive study; comparison will be made between the surface budget and the observed storage. Efforts will be made to explain the differences and then design direct sampling programs to test for the advective transport. Direct measurement of light in the sea has been begun in conjunction with experiments on biological productivity -- more effort will be expended on this part of the work. Experiments with lasers and other artificial light sources will be added in order to learn more about turbidity and other factors affecting light transmission in both sea and atmosphere. Preliminary studies of atmometers for estimating evaporation at sea have been made, and if these prove feasible, they will be used in conjunction with the mass transfer computations to study the evaporation from the sea off Oregon.

SUPPORTED BY U.S. National Science Foundation

3.0036, ATMOSPHERIC EFFECTS ON INCOMING SOLAR RADIATION OVER TROPICAL OCEANS

W.V. BURT, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

The objectives of this research are threefold: (1) to obtain a comprehensive understanding of atmospheric effects on incoming solar radiation over the tropical Pacific Ocean; (2) to develop suitable equations for computing incoming solar radiation over tropical oceans based on meteorological data; and (3) to compute incoming solar radiation over the tropical Pacific based on findings and equations developed.

To accomplish the above objectives it will be necessary to investigate the cloud distribution by type and amount at 5 selected sites (Canton Island, Wake Island, Johnaton Island, Majuro Atoll and Kwajalein Atoll); to determine the effect of various amounts of atmospheric water vapor and clouds on incoming solar radiation; to determine the moist layer thickness at all locations during both disturbed and undisturbed weather conditions; to find suitable correlations between daily precipitation amounts and the occurrences of significant weather disturbances at the sites; to determine the variation in weather conditions and incoming radiation in the vicinity of the equatorial trough; to determine the most suitable cloud parameters to use in equations for computing incoming radiation in the equatorial trough zone and the tradewind region; to determine what other parameters are essential to formulae for computing incoming solar radiation; to use Air Force and Navy summaries to extend study results in space and time; and to develop suitable formulae for computing incoming solar radiation over the tropical oceans through use of hourly atmospheric and radiation data in conjunction with computer programs.

SUPPORTED BY U.S. National Science Foundation

3.0037, FLUXES OF DISSOLVED GASES AND NUTRIENTS RELATING TO BIOCHEMICAL AND AERATION PROCESSES OFF THE OREGON COAST

K. PARK, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Research to date has been on the synoptics of the various chemical parameters in spatial and temperal coordinates. The parameters being investigated are salinity, oxygen, pH, alkalinity, phosphate, and less frequently, silicate and total carbon dioxide. Development of chemical techniques that can be used at sea, such as conductometric alkalinity anlaysis, gas-chromatographic determination of dissolves gases, and the reliability of conductometrically determined salinity has been studied.

It is proposed to study the air-sea exchange in different seasons of inert gases (argon and, for first approximation, nitrogen) and biologically active gases (oxygen and carbon dioxide). Such studies are essential to understand the mechanism of aeration in natural oceanic conditions, and it is quite feasible in this region, because a large annual surface temperature fluctuation, over 8 degrees C at 300 km, occurs off Newport, Oregon.

Quantities of the nutrient matters supplied to the euphotic zone of the ocean by Columbia River outflow and by the process of upwelling will be measured. It is calculated that each of these sources adds approximately one billion moles of phosphate to the euphotic zone off Oregon. The rate of addition of the nutrient by these sources affects the fertility of the euphotic zone.

SUPPORTED BY U.S. National Science Foundation

3.0038, HEAT AND MOMENTUM EXCHANGE PROCESSES BETWEEN THE OCEAN AND THE ATMOSPHERE

G.S. POND, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Objective: Improvements in forecasting marine weather and sea conditions are extremely important to operation at sea. Such improvements will require a more accurate knowledge of the transfer of heat and momentum between the ocean and the atmosphere. This research, by providing a better understanding of the energy exchange processes, will help determine more accurate ways of estimating these exchanges from incomplete environmental data.

Approach: A field experiment using an instrumented tower located about one mile off the Oregon Coast will be carried out. Water vapor concentration, temperatures, wind velocities, and the verticial gradients of each of these variables will be made in the atmosphere immediately above the sea surface. From these data determinations will be made of (i) the amount of heat exchanged between the atmosphere and the ocean, (ii) the similarities and differences between the several physical mechanisms by which heat and momentum are transferred, and (iii) the relations between the amount of heat exchanged and the prevailing meteorological and oceanographic conditions.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0039, SEA-AIR INTERACTION RESEARCH

G.S. COOK, U.S. Navy, Underwater Weap. Res. & Eng. , *Newport, Rhode Island* 02844

Technical Objective: (1) Establish a working knowledge of the mean conditions and the variables involved in the dynamics of small scale processes in the air-sea interaction. (2) Make meaningful observations of the fluxes of momentum, heat, and salt in the air-sea interface region, and to correlate the dynamics of the sea surface with the generation of ambient sea state noise at the air-sea interface.

Approach: One or possibly two tower-type, spar satellite buoys will be implanted near the Buzzards Bay entrance light station. Instrumentation and appropriate sensors will be installed to measure mean air-sea conditions, including air temperature, wind velocity, water temperature, current velocity, wave conditions, and ambient noise. Measurements will be made of the space-time correlation structure and spectra of the wind speed above the air-sea interface and the ambient noise records. Studies will be conducted in the laboratory on turbulent convection in a stably stratified fluid heated from below.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0040, SEA BREEZE INVESTIGATION

K.H. JEHN, Univ. of Texas, School of Engineering, *Austin, Texas* 78712

This work covers the third and final year of an investigation of the sea breeze along the Gulf Coast of Texas. The objectives of this year's work are to analyze and interpret the meso-scale observational data that have been collected during the summers of 1966 and 1967 and to make selected measurements during the summer of 1968.

The meso-scale analysis will center around the objective analysis program that has been made operational on the NCAR CDC-6600 computer. A study of the energy budget associated with the sea breeze will be started. A wind tunnel study and calibration of the liquid water content device used in cloud observations will be completed.

In June 1968 a small field effort will be mounted for the purpose of evaluating the surface input of energy into a sea breeze circulation. Measurements in the boundary layer will be made from several towers. In addition an airborne radiometer will be flown on an NCAR aircraft to determine the surface temperatures over the land and water. Extensive laboratory testing will be required of the instrumentation before going into the field in June.

SUPPORTED BY U.S. National Science Foundation

3.0041, AIR-SEA INTERACTION

G.A. FRANCESCHINI, Texas A & M University System, Graduate School, *College Station, Texas* 77843 (NONR)

The goal of this effort is to develop methods of predicting changes in conditions within the boundary layers of the sea and atmosphere from routinely available data. Of immediate concern is the exchange of sensible and latent heat and its relation to near surface gradients of temperature and humidity. An observational program is being planned and associate equipment designed and field site selected during the coming year.

This study sould improve our knowledge of spatial and temporal variations of temperature in the ocean and thus work toward eventual systems for predicting environmental conditions.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0042, AIR-SEA INTERACTION

D.F. LEIPPER, Texas A & M University System, Graduate School, *College Station, Texas* 77843 (NONR)

The objective of this task is to develop accurate forecasting methods for oceanic phenomena which are dependent upon air-sea interactions using tools of synoptic oceanography. Particular attention is being payed to the currents and thermal structure in the eastern Gulf of Mexico and the ways in which they change seasonally and in response to weather conditions.

It is expected that these studies will contribute to the development of oceanic forecasting methods particularly the influence of large-scale weather systems upon ocean temperature.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0043, HYDROSPHERE-ATMOSPHERE RADIOCHEMICAL MEASUREMENTS

A.W. FAIRHALL, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The excess carbon-14 introduced into the northern hemisphere stratosphere during the 1961-1962 USSR and US nuclear weapons tests provides a useful tracer for the study of atmospheric mixing processes and exchange of carbon dioxide between the atmosphere and the surface of the sea. To study these processes the troposphere and the surface of the sea are sampled periodically, at various locations within both the northern and southern hemispheres, for carbon-14. The studies to date show that atmospheric dispersion of trace substances is well accounted for by eddy diffusion, the horizontal eddy diffusion coefficients being proportional to the variance of the wind speed. The exchange of carbon dioxide with the sea is shown to be proportional to the square of the average wind speed over the sea surface.

SUPPORTED BY U.S. Atomic Energy Commission

3.0044, ENERGY TRANSFER NEAR THE EARTHS SURFACE

R.G. FLEAGLE, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The principal objective of this proposal is to complete the development of the capability for making reasonably accurate measurements of vertical turbulent flux. It is anticipated that during the period of time involved objectives will be formulated to take advantage of and contribute to the developing national and international programs involving energy transfer in the atmospheric boundary layer.

To complete the development work, it is planned to hold several comparative experiments between instruments for measuring turbulence statistics. Studies will be made analyzing the motions of the MENTOR buoy, measuring the vertical fluxes of heat and momentum simultaneously over different surfaces, determining the spectra of the fluxes and establishing the Kolmogoroff constant for momentum and temperature.

SUPPORTED BY U.S. National Science Foundation

3B. HURRICANES-STORMS

3.0045, ATMOSPHERIC CONDITIONS ASSOCIATED WITH CUMULUS CONVECTION

W.M. GRAY, Colorado State University, School of Engineering, *Fort Collins, Colorado* 80521

To continue investigation of the wind speed, vertical shear, and baroclinicity in the inner areas of tropical storms and develop a model to fit the observed cumulus convection. To continue a statistical study of frictional turning of wind in the sub-cloud layers over the tropical oceans.

Most of the work will utilize RFF flight data since much of the area under study is over tropical oceans. In addition, large quantities of data supplied by Asheville, and special tower observations will be utilized.

During the period of previous support results indicated that most tropical disturbances from which storms form are generated from an environment in which a horizontal shearing zonal trade wind current is present with minimum tropospheric vertical shear.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0046, HURRICANES AND OTHER TROPICAL METEOROLOGICAL PROBLEMS

R.C. GENTRY, Univ. of Miami, National Hurricane Res. Lab. , *Miami - Coral Gables, Florida* 33124

The scientific objectives of NHRL are to acquire greater knowledge of tropical cyclones and their environment; to develop improved techniques for forecasting hurricane motion, formation, dissipation, and intensification; and to develop and/or evaluate hypotheses of tropical cyclone modification. Specially equipped research aircraft, weather satellites, and conventional surface and upper air networks will be used to obtain data to study the structure, dynamics, and high energy processes of the tropical cyclone. These data will also be used to determine interactions between the tropical cyclone and its environment in efforts to determine what are the factors involved in hurricane formation, intensification, dissipation, and movement. Tropical cyclone genesis and maintenance are being studied by the development of dynamical-numerical models of tropical circulations. Efforts to continue modification experiments on hurricanes will be intensified. Primary emphasis will be placed on the experiment to conduct multiple seedings of the eye wall of a mature hurricane. Second priority will be given to modification experiments on the rainband of a hurricane.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0047, TRITIUM IN HURRICANES

H.G. OSTLUND, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

To use the radioactive hydrogen isotope tritium, T, as a tool in air/sea interaction studies. Since the exchange of molecules at the interface is closely related to the flow of latent and sensible heat, the results could give experimental verification to hitherto only vaguely known exchange coefficients, and the energy budget of the system.

Using aircraft, take separate samples of liquid water and water vapor for analysis of tritium content. Relating points where samples were taken to positions in the hurricane or tropical storm. From the analysis, the total exchange of water at the air/sea interface may be deduced.

Some preliminary experiments were conducted in 1964, 1965, 1966. These experiments indicate that the total exchange of water at the air/sea interface is intense. Also the radial distribution of inflow into a hurricane was deduced, along with the air/sea exchange coefficients for water vapor.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0048, TROPICAL STORM INVESTIGATIONS IN THE ATLANTIC, CARIBBEAN, AND GULF OF MEXICO

N.E. LASEUR, Florida State University, Graduate School, *Tallahassee, Florida* 32306

Objective - Lack of conventional meteorological data has hindered a complete analysis of disturbances in the tropical oceans during the course of a typical season. Project objectives are: (a) to produce a sequence of analyses tropical oceanic areas extending from the Gulf of Mexico eastward to 10 degrees E., and investigate characteristic features of waves, anticyclonic centers, major convergent lines and other significant systems. (b) The development, extension and testing of hypotheses based on comparisions of satellite,

Approach - All data are being incorporate into complete analyses using both forward and backward time continuity. Wave and vortex systems will be tracked to gain information on size, intensity and speed of motion. During periods of concurrent coverage, satellite data will be used to investigate the intensity of disturbances and their vertical motion field.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0049, TROPOSPHERE METEOROLOGY IN THE TROPICAL ATLANTIC AREA

N.E. LASEUR, Florida State University, Graduate School, *Tallahassee, Florida* 32306

It is intended that the work remaining in the preparation and analysis of derived quantities (divergence, vorticity, deformation) and auxiliary fields (clouds and precipitation) will soon be completed. The problems of anomalous anticyclone gradient balance between the wind and pressure fields will be pursued.

The approach will be to solve the balance equation in its usual elliptic form in regions of cyclonic flow and normal anticyclonic gradient balance plus the solution of the hyperbolic form of this equation in regions of anomalous anticyclonic gradient balance.

Analysis of surface and upper tropospheric chargs over the Tropical Atlantic region has been carried out over the past five years. In addition analyses have been made of cloud and precipitation information collected for the IGY period. Work continues on the problem of anomalous wind cases associated with subtropical westerly and easterly jet-streams.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0050, RESEARCH ON DYNAMICS OF LOW LATITUDE CIRCULATIONS

H.L. KUO, Univ. of Chicago, Graduate School, *Chicago, Illinois* 60637

Objective - At low latitudes, particularly over the oceans, conventional meteorological observations are scarce and atmospheric circulations are poorly understood. Project objective is to continue theoretical studies currently underway directed primarily to the formation of easterly waves and hurricanes. This involves the development of numerical models to simulate hurricane formation, and includes theoretical investigation of convection and low latitude wave pertubations.

Approach - Increasingly more complex and complete models will be designed to study hurricane formation. Effects of diurnal heating and vertical wind shear will be incorporated in the studies of convection motions. Results will be described in a comprehensive Final Report.

Progress (to June 30, 1967): Little progress this period because of problems with the multi-level hurricane model. Grant has been extended six months.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0051, DYNAMIC STUDY OF THE TEMPORAL

A.J. PALLMAN, Saint Louis University, School of Engineering, *Saint Louis, Missouri* 63103

Technical Objective: To continue the study of the 'temporal' in terms of a dynamic-energetic model incorporating earlier findings to establish the important characteristics of the temporal at maturity as well as at its formation. Comparison to major tropical storm characteristics will then be possible.

APPROACH: By use of Nimbus II radiation data, AVCS photographs and conventional data, another 'temporal' case of June 20-27, 1966 will be studied. Results will be presented in a written report.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0052, LAKE EFFECT SNOWSTORM STUDY

V.J. SCHAEFER, State University of New York, Atmospheric Sciences Res. Ctr., *Albany, New York* 12203

The primary objective of this research is to conduct studies on the effects that the Great Lakes have on lee side snow fall.

The approach will be focused on continuous monitoring of atmospheric nuclei and of snow crystal types during the snowstorms which occur and relate these to snow fall, wind direction and related phenomena. In addition, patterns of convergence, generation of clouds, snow distribution will be studied. Until these features are well established, it will be difficult to develop an engineering design to properly modify these storms. Orographic phenomena also will be studied.

Work accomplished under the grant has been the establishment of a mesoscale observation network downwind of both Lakes Erie and Ontario.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0053, HURRICANE DYNAMICS FOR ARTIFICIAL MODIFICATION STUDY

K. OOYAMA, New York University, School of Engineering, *New York, New York* 10003

This grant provides support for the third and final year of research carried out formerly under GP-5192 and GA-623 on the activities of K. Ooyama in studying the structure and behavior of hurricanes using mathematical models on high speed electronic computers. The first objective of the project to construct a simple model of a hurricane to understand the basic hurricane dynamics has now been achieved. This extension will permit work to be initiated on a numerical model which would be accurate enough to predict the behavior of real hurricanes. The restrictive assumptions in the present model, such as gradient wind balance and axisymmetry, will have to be replaced by more realistic boundary conditions.

SUPPORTED BY U.S. National Science Foundation

3.0054, SEVERE STORM CLIMATOLOGY

W.H. HAGGARD, U.S. Dept. of Commerce, Nat'l. Weather Records Ctr. , *Asheville, North Carolina*

To investigate the spatial and temporal variations in 1) the synoptic patterns associated with the subsequent development as well as non-development of tropical cyclones; 2) the contribution of the storms to the precipitation distribution patterns over specific land areas; and 3) the low-level meteorological phenomena associated with severe frontal passages and to relate satellite cloud photos to time and degree of recurvature of hurricane paths. Climatological models will be developed to provide the probable distribution of significant parameters such as wind and moisture.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3C. GENERAL METEOROLOGY-CLIMATOLOGY

3.0055, AN EXPERIMENTAL AND THEORETICAL STUDY OF THE MARINE AND CONTINENTAL CLIMATES OF POINT CONCEPTION TO THE MORRO BAY REGION OF CALIFORNIA

J.A. ROBERTS, Meteorology Research Inc. , *Altadena, California*

Technical Objective: An improved scientific understanding of the marine elements of coastal climates and of the effects of topography on micrometeorology of the coast and a more complete basis for predicting environmental conditions affecting military landing and beach clearance operations.

Approach: Micrometeorologic and marine data on the California coast from Point Conception to Morrow Bay will be collected and analyzed. This portion of the coast has been classified as a single climatic type and contains a variety of coastal land forms. Data will be collected from three instrument ranges, eleven coastal reporting stations, and a series of seasonal aircraft operations. The data will be reduced and analyzed with respect to the general synoptic situation and related to seasonal climatic conditions.

Progress: Three mechanical weather stations were sited around each of the three headlands, Pt. Arguello, Pt. Sal and Pt. Buchon, for a total of nine installations. Each station consists of wind direction and speed, air temperature and precipitation gauges. Atmospheric soundings are made by an MRI aircraft instrumented to take continuous measurements of temperature, humidity and turbulence as a function of elevation. Intensive field observations were conducted during two periods, 31 May to 3 June and during the week of 22 August, including special measurements of wind and observations of cloud cover, in addition to wind data being measured by the network of mechanical weather stations.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0056, MESO WIND PATTERNS IN THE CENTRAL CALIFORNIA VALLEY

W.E. YATES, Univ. of California, School of Agriculture, *Davis, California* 95616

The proposed research has emerged from studies on drift of herbicides and insecticides, air pollution, and wind erosion. Exploratory surveys on a modest scale in parts of the Central Valley of California resulted in the discovery of some peculiar wind patterns in the lower Sacramento and lower San Joaquin Valleys. Spraying schedules in parts of this area could be established for agricultural aircraft operators, and suitable wind protection devices could be designed in another part.

The study is carried out by establishing several portable climate recorders that include wind registering in various sites of the Valley. A further observation tool is a 1,500 ft. TV tower, which was equipped also with six or these recorders at various heights. Furthermore, pibal observations and airplane cruises are employed. The data will permit obtaining basic knowledge of the particular wind patterns, and generally about the interaction of the phenomena of sea breeze and continental pressure systems about 100 miles from the coast.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0057, PACIFIC OCEAN INFLUENCE UPON CALIFORNIA RAINFALL

J. BJERKNES, Univ. of California, Graduate School, *Los Angeles — U.C.L.A. , California* 90024

In project research for the National Science Foundation carried on by the principal investigator it has been found that the Pacific Ocean temperature varies more from year to year near the equator than it does in adjacent areas to the north and south. It has also been demonstrated that the inter-annual variation in heat and moisture input from the equatorial belt of the oceans in the few instances investigated does influence the global pattern of the atmospheric circulation. On the basis of this experience it is tentatively assumed that the variation of rainfall from year to year in California, and other areas around the Pacific Ocean, primarily results from the variability of the water temperature at the equator.

It is planned to test this hypothesis by assembling maps of the atmospheric circulation for all winter seasons during which equatorial water temperature measurements were carried out. Next, the map types will be correlated on the one hand with equatorial water temperatures and on the other with the historical rainfall record in California.

The problem of estimating the yield of a rainy season on the basis of atmosphere and ocean data, available before the rains start, will be investigated.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of California

3.0058, CLIMATE CHANGE OVER THE POLAR OCEAN

S. ORVIG, Mcgill University, Graduate School, *Montreal - Quebec, Canada*

Orvig proposes to continue studies of climatic effects resulting from heat transfer process in the Arctic. The objective is to attain numerical values for all the terms in the heat balance equation for the surface and the atmosphere over the Polar Ocean. This work will supplement the U.S. work by making available to the large numerical projects, hand computed input values of areal values of conditions, radiative energy fluxes, cloud conditions, etc.

SUPPORTED BY U.S. National Science Foundation

3.0059, ATMOSPHERIC PROCESSES IN THE TROPICS

W.M. GRAY, Colorado State University, School of Engineering, *Fort Collins, Colorado* 80521

The objective of this research is to study the tropical atmosphere through a continuation of observational studies of atmospheric processes using data collected from satellites, aircraft, surface ships and conventional synoptic observations.

The objective is to be achieved by studying three primary physical processes. They are: (1) the mutual variation of wind, shear and baroclinicity in tropical storms and disturbances; (2) a statistical treatment of the Ekman or frictional turning of the wind in the sub- cloud layer within the tropics; and (3) the association, movement and conservatism of the satellite-observed 'cloud blob' areas in and surrounding the Inter-Tropical Convergence Zone for a better understanding of the dynamics of this system.

The proposed work is part of a continuing mutual research effort with Professor Yanai of the Department of Geophysics at the University of Tokyo. All of this work is related directly to the Tropical Meteorological Experiment (TROMEX) to be carried out in the early 1970's and to the Global Atmospheric Research Project (GARP) to be carried out in the mid or late 1970's.

SUPPORTED BY U.S. National Science Foundation

3.0060, WEATHER PROGRAM - STATION T-3

V. ROCKNEY, U.S. Dept. of Commerce, Weather Bureau, *Washington, District of Columbia*

Standard Weather Bureau methods are utilized to provide a program of surface and upper-air weather observations on Drift Station T-3, an ice island research station in the Arctic Ocean Basin. Surface observations are made on a minimum of 6-hour basis and Rawinsade probes of the upper atmosphere are made two times daily.

3. METEOROLOGY

Routine standard weather observations contribute to a climatology of the Arctic and will provide bacground for all future Navy operations in Arctic seas. Daily observations and forecasts are necessary for air support of the drifting station itself as well as international aviation. Upper air data are of special importance to investigations of the Arctic Ocean energy balance which is studied on a continuing basis on T-3. It is especially important that the polar atmospheric circulation be known in detail and that its relation to world weather and ice distribution and behavior be better understood.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0061, TROPICAL ANALYSIS AND FORECASTING

***L.W. VANDERMAN*, U.S. Dept. of Commerce, Natl. Meteorological Ctr., *Washington, District of Columbia* 20233**

Objective - Tropical numerical analysis and forecast programs are being developed for an integrated operational analysis and forecast program as a part of NMC's support to the World Meteorological Center (Washington).

Approach - Tropical analyses for five pressure levels are being computed twice per day and primitive equation barotropic forecasts to 36 hours for two pressure levels are being computed once per day on an experimental-operational basis. Efforts at meshing a tropical belt forecast with a high latitude forecast have continued. A two-layer primitive equation baroclinic forecast model for the tropical belt has been developed and run. Considerable effort has been given the development of a global forecast grid and equations. This grid includes the tropics as a sub-set of the grid points.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0062, MESO AND CONVECTIVE SCALE SYSTEMS IN THE MARITIME TROPICAL ATMOSPHERE

***M. GARSTANG*, Florida State University, Graduate School, *Tallahassee, Florida* 32306**

The primary objective of this research is to conduct studies which will lead ultimately to the construction of a model of convective scale systems in Maritime tropical atmospheres. This model will be developed both theoretically and by extensive observations in the field.

The approach will be based on a computer model of the heated island, determining the characteristics of the velocity field over a heated island, and extensive field experiment to test the model and hypothesis.

Work accomplished under the grant has been the near completion of a numerical (computer) model of the heated island and the development of instrumentation necessary to gain the above objectives.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0063, LINE ISLANDS EXPERIMENT

***C.S. RAMAGE*, Univ. of Hawaii, Hawaii Inst. of Geophysics, *Honolulu, Hawaii* 96822**

The objective of this work is twofold: (1) to collect and process observations made during the Line Island Experiment for use by all participants in the experiment and any other interested parties and (2) to investigate synoptic and sub-synoptic weather processes and climatology in the region of the Line Islands during the operation of the ATS-B satellite.

To accomplish the first objective all routine weather observations made over the Pacific (130 degrees E-80 degrees W and 40 degrees S) during the Line Island Experiment will be collected, processed, plotted, analyzed and listed in a publication put out by the University of Hawaii.

The second objective will be accomplished by independent investigations under the following topics: LaGrangian dynamics, ocean- atmospheric momentum exchange, climatology of the Line Islands, Line Islands weather in the contect of the total tropics, and atmospheric tides.

SUPPORTED BY U.S. National Science Foundation

3.0064, MESOSCALE WIND SYSTEMS AROUND THE GREAT LAKES

E.W. HEWSON*, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan

The research to be undertaken is concerned with the structure and dynamics of lake and land breeze systems around Lake Michigan. The field program will conduct measurements during May and June near the eastern shore of Lake Michigan between Holland and Muskegon. The field measurements are several pilot balloon observations of winds aloft to be taken along a line extending eastward from the shore, and at distances of 0, 5, 10, and 15 miles from it. Pilot balloons will also be taken from a vessel over the lake. Lapse rate measurements of temperature and moisture will be obtained over land and lake using an instrumented manned aircraft.

The above measurements will be used for comparison with a theoretical model of a lake-land breeze system. Numerical analysis using a digital computer will be employed to achieve the required solutions.

The results will be of substantial value in the analysis and control of interstate air pollution problems.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0065, GREAT LAKES RESEARCH - LAKE PRECIPITATION

***J.A. DERECKI*, U.S. Army, Lake Survey, *Detroit, Michigan* 48226**

Purpose is to determine the precipitation over the large water areas of the Great Lakes and to derive methods to calculate the overwater precipitation from the overland records.

In cooperation with U. S. Weather Bureau, the lake precipitation is being recorded on selected small islands. In Lake Michigan precipitation recording started October 1963 on South Manitou, North Manitou, South Fox, Beaver and Ile aux Gallets Islands. In Lake Erie precipitation recorders were placed on West Sister and East Sister islands during May 1964. Field program will continue through October 1968. Hourly precipitation data are available in tables and on punch cards.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0066, EQUATORIAL CIRCULATIONS IN THE STRATOSPHERE

***A.D. BELMONT*, Control Data Corporation, *Minneapolis, Minnesota* (AT(11-1))**

The object of this study is to help understand the nature of the field of motion in the tropical stratosphere. The results will be applicable to problems of atmospheric transport in this region.

As a continuation of earlier studies, selected aspects of the tropical stratospheric wind flow patterns from January 1961 - December 1964 as functions of height, latitude and longitude, will be described. Emphasis will be placed on estimating cross-equatorial flow both on a planetary scale and on the local scale at selected stations. As the winds at these base levels in tropical latitudes do not follow normal seasonal or monthly patterns, but are mainly dependent on the irregular quasi-biennial oscillation, multi-year mean monthly or seasonal statistics are of no significance, and all data must be presented for individual months and years. Studies of the diurnal variation of the meridional wind and its effect on computations of cross-equatorial transport will also be made.

SUPPORTED BY U.S. Atomic Energy Commission

3.0067, THREE-DIMENSIONAL GLOBAL CLIMATOLOGY

H.L. CRUTCHER*, U.S. Dept. of Commerce, Natl. Weather Records Ctr., *Asheville, North Carolina

To determine: 1) the static structure of the atmosphere from the surface to as great height as is feasible; 2) the dynamic structure of the atmosphere by spectral analysis which is expected to provide preferred modes of motion in the atmosphere in the three dimensions, latitude, longitude, and altitude; and 3) the various time scales indicated to be important by the spectral analysis.

To study geophysical data generally with respect to accuracy and representativeness and with a view to practical applications of these disciplines singly or in combinations.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3D. SEA ICE-GLACIOLOGY

3.0068, CARBON MONOXIDE CONTENT OF GLACIAL ICE AND THE NATURAL ATMOSPHERE

R.C. ROBBINS, Stanford Research Institute, ***Menlo Park, California***

Carbon monoxide is one of the gases found in trace amounts in the earth's atmosphere. A very approximate estimate of the background concentration of carbon monoxide, based on information available to date, is 0.2 ppm or less. The total global emissions in automobile exhaust and other combustion processes is so large that carbon monoxide lifetime in the atmosphere cannot be more than a few years. The object of this research is to study the travel, distribution, and fate of atmospheric carbon monoxide by determining concentrations in remote areas having no combustion sources. Carbon monoxide concentrations in the Atlantic and Pacific, and in the northern and southern hemispheres will be measured. Examination of the concentration data will provide a much more comprehensive estimate of carbon monoxide lifetime in the atmosphere as well as improved ideas regarding the principal sink or sinks.

The assistance of Military Sea Transport Service will be requested to carry our CO analyzer with a technician on Atlantic and Pacific Ocean crossings. Also, we plant to make airborne measurements of CO concentration from an aircraft to an altitude of 25,000 feet in the vicinity of the California coast to obtain vertical carbon monoxide concentration profiles.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0069, MEASUREMENT OF COMMON LEAD IN THE EARTHS HYDROSPHERE

C.C. PATTERSON, Calif. Inst. of Technology, Graduate School, ***Pasadena, California*** 91109

The purpose of this investigation is to determine the change as a function of time in the concentration of lead in snow from polar regions. In order to understand the significance of the observed lead concentrations, it is necessary to determine the concentration of some other elements as well, such as chloride, sulphate, sodium, potassium, silicon, vanadium, calcium, magnesium and aluminum. It is hoped that we can detect lead originating from industrial sources, and those other elements can be used as indices for lead originating from both industrial and non-industrial sources. Sodium and potassium can be used as an index for the contribution from sea salts, for example, while chlorine can be used to estimate contributions from volcanic contaminations. Silica and aluminum can be used to estimate contributions from soil dusts. Sulphate, when combined with sulphur isotopic analyses, can be used to estimate the possible extent of industrial contributions.

During 1965 summer field season, a large number of snow samples were collected from Greenland. The analyses of these samples for lead and the other elements listed above will involve approximately 880 determinations using the following techniques; isotope dilution, flame spectrophotometry, atomic emission spectography, colorimetry and nephelometry. The amount of work involved here is extensive and it is expected that these investigations will extend through 1967.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0070, ARCTIC UNDERSEAS RESEARCH, PHYSICAL AND CHEMICAL PROPERTIES OF SEA ICE

W.K. LYON, U.S. Navy, Undersea Warfare Center, ***San Diego, California*** 92140

Objective: To determine environmental factors affecting undersea uses of the ocean in Arctic areas. To determine the physical and chemical properties of sea ice. To model sea ice growth and break-up in the Laboratory Arctic Research Pool.

Approach: A large pool, completely insulated, has ice weather-makers above the water. The pool has been modified by installation of monel piping to reduce ferric ion. The capability of the pool to grow laboratory sea ice equivalent in chemical and physical structure to sea ice is being evaluated. Programmed inputs of weather cycles are approximated from actual Arctic conditions.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0071, ARCTIC UNDERSEAS RESEARCH, JOINT USA-CANADIAN HEAT BUDGET STUDY

W.K. LYON, U.S. Navy, Undersea Warfare Center, ***San Diego, California*** 92140

Objective: To determine environmental factors affecting undersea uses of the ocean in Arctic areas; determine and test theory of heat exchange adjusted to climatological observations.

Approach: Fundamental to ocean-cryological processes, is an understanding of energy transfer between the atmosphere, sea ice and sea beneath. Very large capacity, high speed data logging systems and many new, precise sensors are required and have been designed to permit direct processing of field data by computer. Precise measurements are made of temperature, wind speed and direction, turbulence, heat flow, water vapor, water transport, radiation, etc. The system includes cabling, buoys, towers, generators. After check-out of circuitry and calibration, as a joint USA-Canadian research project, the two barges and shore equipment will be installed in Jesse Harbor on Banks Island of the Canadian Arctic Archipelago. Installation is planned for FY 1969 if preliminary buoy installations last out the winter.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0072, ELECTRICAL PROPERTIES OF ICE

E.R. POUNDER, Mcgill University, Graduate School, ***Montreal - Quebec, Canada***

Systematic investigations are to be extended to include the electrical parameters of saline ice with salinity typical of natural sea ice at selected audio frequencies in the temperature ranges minus 20 degrees C to minus 100 degrees C to look for the effect of the phase changes in the composition of sea ice. These are expected to have significant results only at relatively low audio frequencies. To carry out similar measurements at a single temperature (minus 20 degrees C) over the frequency range 40 to 3000 HW.

This task will contribute to the ice reconnaissance operations employing radar and other electromagnetic techniques, as well as a greater understanding of propagation phenomena associated with radio communications, under, through and over sea ice.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0073, HF AUDIO ABSORPTION IN ICE

E.R. POUNDER, Mcgill University, Graduate School, ***Montreal - Quebec, Canada*** (NONR)

An experimental study of high frequency audio adsorption in ice to investigate systematically the acoustic attenuation of sea ice as a function of frequency and salinity; to make reverberation measurements on sea ice at selected frequencies (100, 200, 500, 1000 KC); to measure reflection coefficients of sound waves incident from the water on the ice-water interface at selected frequencies and for a wide range of angles of incidence.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0074, ARCTIC SUB-ICE STUDY

R.C. FAYLOR, Arctic Inst of North America, ***Washington, District of Columbia***

The contractor will provide coordination, liaison and focal point for the conduct of a multidiscipline, miltiagency program of under-ice acoustic, marine biological and sea ice investigations from the deep submersible vehicle PISCES. A series of dives throughout the Arctic Archipelage and Arctic Ocean under ice will be made to investigate marine biology, marine mammal acoustics, sub-ice acoustic regime and sub-ice oceanography.

3. METEOROLOGY

Investigations supported by this task provide the Navy with new information on sub-ice underwater sound.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0075, SATELLITE SEA ICE STUDIES USING HRIR

E.P. MCCLAIN, U.S. Dept. of Commerce, Environ. Sci. Serv. Admin., *Washington, District of Columbia* 20235

OBJECTIVE: To determine the usefulness of HRIR data in the 3.5- 4.1 micron water vapor 'windows' region for Arctic sea ice surveillance.

PROBLEM ADDRESSED BY STUDY: Knowledge of polar ice distribution and characteristic is essential for understanding large-scale, long-range climatic changes in the atmosphere. In addition, flight operations, shipping interests, exploratory petroleum-drilling efforts, and eventually manned space activities, all require knowledge of sea ice conditions in polar regions, particularly as these conditions affect, or are affected by, weather conditions. Very little definite knowledge of sea ice conditions in the polar regions is now available, and the task of acquiring such knowledge is enormolus if attempted by surface or near-surface observation.

This study is aimed at determining the extent to which satellite HRIR data may be applied to determine sea ice characteristics in the Arctic Ocean and environs.

APPROACH: Nimbus I and II HRIR pictorial and digital data will be compiled and examined to determine the amount and quality of sea ice information which can be extracted. Ice covered areas will be identified and differentiated from clouds primarily through recognition of terrestrial features. Ice boundaries and open water areas will be delineated. The frequency with which useful IR observations can be obtained will be estimated. A comparison of data obtained from both satellites will be made to determine whether the higher resolution (because of the lower altitude) of Nimbus I results in a significant improvement in the capability of the system for ice surveillance.

PROGRESS: Several studies have been made of the uses of Nimbus NRIR data for observing terrestrial features. Popham and Samuelson found that the HRIR could detect considerable detail over the polar regions, with cracks in the pack ice of the Weddell Sea being readily apparent. However, no detailed studies of HRIR observations over ice areas have been conducted.

BENEFITS: This study will determine the feasibility of using satellite IR observations for ice and weather surveillance in the Arctic regions.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

3.0076, ICEBERG DRIFT AND DETERIORATION

M.J. MOYNIHAN, U.S. Dept. of Transportation, Oceanographic Unit, *Washington, District of Columbia*

The U. S. Coast Guard is continuing to improve the capability and effectiveness of its International Ice Patrol Mission. Data on iceberg drift and deterioration has been routinely collected by the Ice Patrol now more than fifty years. Since 1964, special observations of icebergs by drogue and current meter measurements and by photo mapping techniques have been conducted in order to develop an iceberg model to support the iceberg drift prediction mission of the Ice Patrol Service. These measurements will be correlated with hydrographic data collected at the same time.

The special data collection phase of this project has been terminated and a complete report will be published by the U. S. Coast Guard in the Oceanographic Report Series (CG-373).

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

3.0077, WEST GREENLAND GLACIER SURVEY

M.J. MOYNIHAN, U.S. Dept. of Transportation, Oceanographic Unit, *Washington, District of Columbia*

In July 1968, the U.S. Coast Guard conducted a comprehensive oceanographic and geological expedition to twelve tidewater glaciers of West Greenland. The purpose of these expeditions was to study the source of the iceberg menace to the North Atlantic Shipping Lanes. This was the first study in this area by the International Ice Patrol since 1940 and it constitutes the first phase of a three year project to study the productivity patterns of these glaciers, which are estimated to discharge annually 5400 icebergs.

The objectives of this series of annual expeditions are: (a) To determine the present number of icebergs calved from the major West Greenland iceberg producing glaciers. (b) To survey the glacier fronts and compare these data with earlier records to ascertain the advance, or recession, of the glacier termini. (c) To study the environmental conditions affecting the discharge and drift seaward of icebergs from the parent glacier.

Observations include an inventory of iceberg size, type, distribution, and movement. Glacier fronts were charted and bench marks established wherever possible to aid future surveys. Oceanographic observations are made at selected sites within the fjords and in the offshore waters. Photography of fjord bottoms, and significant marine life with an underwater camera and of major glacier fronts from camera equipped Coast Guard aircraft are planned.

The scientific results of this expedition with contributions from invited scientists will be published by the U.S. Coast Guard in the Oceanographic Report (Series CG-373).

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

3.0078, PREDICTION OF POLAR ICE BEHAVIOR AND DISTRIBUTION

W.I. WITTMANN, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objective: Expand and improve sea ice data collection, prediction, and dissemination services. Special emphasis is on prediction of underice ridges and dynamics of water features and thin ice features. As a corollary objective, these studies improve estimates of the global mass budget of ice and consequently global weather prediction.

Approach: Continue collection of ice information on an Arctic Ocean wide basis for a bank of statistical data concerning distributions, dizes, and frequencies of water openings, ice ridges, stages of ice development and other variables affecting operations. Implement a program involving coincident observation and measurement, over a wide ice covered region (i.e. 10,000 nm2), of ice-water stresses, air-ice stresses, ice motions and deformations. This program will use airborne remote sensor support.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0079, ARCTIC AND COLD WEATHER SUPPORTING TECHNOLOGY

M.M. KLEIMERMAN, U.S. Navy, Ordnance Laboratory, *Silver Spring - White Oak, Maryland*

Approach: This effort comprises a series of studies and field experiments conducted in-house; by U. S. and Canadian activities, and by industrial activities. There is no underice range in existence at the present time. Naval Ordnance Laboratory, Naval Underwater Research and Engineering Station, and Canadian DRIA are engaging in a cooperative effort for establishment of such a range in Nova Scotia, Canada. Stevens Institute is conducting model tank studies of bottom pressure fluctuations under an ice cover. Acoustics of the ice-water interface are being investigated by McGill. Seismic acoustic transmission through ice is being developed by General Motors.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0080, ARCTIC SUPPORT

M.M. KLEIMERMAN, U.S. Navy, Ordnance Laboratory, *Silver Spring - White Oak, Maryland*

Approach: This task area, with the Naval Ordnance Laboratory, White Oak, Maryland Laboratory, consists of several basic studies of the effect of high latitude environment on systems and the ways and means of coping with difficulties imposed by sea ice and/or cold weather. These studies consist of analytic approaches, laboratory experiments, and field measurements. Included are ice impact and penetration dynamics and remote sensing of ice thickness.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0081, GREAT LAKES RESEARCH - RIVER ICE JAMS

S.J. BOLSENGA, U.S. Army, Lake Survey, *Detroit, Michigan* 48226

The causes of ice jams in rivers and methods of possible elimination of destructive jams or reduction of their power are being studied.

In the first step of the study pertinent manuscripts from all areas of the world have been collected, examined, and summarized. Foreign language manuscripts account for a significant portion of the items and were translated as required. Report acquisition was through standard library sources, translation agencies, and by direct contact with investigators in the field.

The final results of the survey will be a narrative summary and selected bibliography prepared from the reports. Completion will be in June 1968.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0082, GREAT LAKES RESEARCH - ICE CHARACTERISTICS

E.W. MARSHALL, U.S. Army, Lake Survey, *Detroit, Michigan* 48226

The investigation seeks to determine the physical characteristics of ice cover in the Great Lakes by field measurements and laboratory analysis of samples from representative localities.

Field investigations are conducted during the 1965-66 and 66-67 winters in the Whitefish Bay area of Lake Superior. Among the factors investigated were: ice thickness, structure, crystal size and orientation, floe characteristics, pressure ridge configuration and ice foot formation. Aerial photomapping provided control for selection of ice samples and a permanent record for additional investigations. Micrometeorological measurements were taken at Whitefish Point during the 1966-67 season with particular emphasis on global radiation in four spectral bands. Petrographic studies of the ice samples collected in the field are conducted in the cold laboratory.

During the 1967-68 winter season studies will be continued in Whitefish Bay and extended to other areas on and near Lake Superior.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0083, GREAT LAKES RESEARCH - ICE COVER DISTRIBUTION

E.W. MARSHALL, U.S. Army, Lake Survey, *Detroit, Michigan* 48226

This investigation seeks to determine the changes that take place in the areal distribution, structure, and imagery of the Great Lakes ice cover throughout the winter.

Currently three methods and levels are employed: low level visual reconnaissance, up to 8,000 feet, medium altitude aerial photography, 23,000 feet, and high level satellite imagery, 400 to 800 nautical miles.

The visual aerial reconnaissance program provides the extent and relative concentration of ice. These observations are coordinated with those of the Canadian Department of Transportation which covers the Canadian portions of the Great Lakes. These observations provide a general synoptic view of ice conditions at 10-15 day intervals.

Aerial photomapping of the ice cover at the scale of 1:46,000 is carried out over eleven areas critical to Great Lakes shipping. Weather satellite imagery is monitored to aid in determining ice distribution and program planning.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0084, GREAT LAKES RESEARCH - GREAT LAKES DEICING

E.W. MARSHALL, U.S. Army, Lake Survey, *Detroit, Michigan* 48226

This investigation will prepare three reports (1) Annotated bibliography based on the world's literature on the natural conditions of the formation and decay of freshwater ice on lakes, harbors, rivers and locks as well as scientific and engineering information on techniques used to aid the delay of ice formation and to accelerate the ice in both fresh and marine environments. (2) A summary of the pertinent papers identified in the above and (3) A summary of information developed by the in-house projects of the Research Center on Great Lakes ice characteristics and areal distribution.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0085, PHASE RELATIONS OF THE HYDRATED CARBONATES OF CALCIUM AND MAGNESIUM

D.L. GRAF, Univ. of Minnesota, Graduate School, *Minneapolis, Minnesota* 55455

The project is concerned with determining the equilibrium phase relations and crystal structures of the carbonates of calcium and magnesium. A knowledge of these phase relations will help one to understand the effect of surface reactions and solution structure upon the kinetics of nucleation, growth, and solution of both hydrated and anhydrous Ca and Mg carbonates in aqueous solutions. The broad understanding of interactions between carbonate solids and water afforded by the total program would be particularly relevant to the formation of dolomite and to the physical properties of sea ice.

SUPPORTED BY U.S. National Science Foundation

3.0086, SPECIALIZED RESEARCH EQUIPMENT FOR SEA ICE STUDIES

K.O. BENNINGTON, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The proposed research by the University of Washington will allow for the purchase of specialized equipment for a study of differential pressure and internal stresses that develop in sea ice as it freezes during the polar winter. The data that may be gained from this research is basically an understanding of the driving forces that are instrumental in the escape of brine from sea ice. A correlation will be attempted between temperature waves, the resulted pressure waves, and associated compositional changes during the formation and aging of sea ice. Such a correlation has not previously been made. This research project by the University of Washington was begun during the winter of 1966-67, and the equipment that is proposed to be acquired would allow the expansion in both data obtained and in the sophistication of the research. The study of sea ice is an interdisciplinary field between oceanography, glaciology, meterology, and physics that is essentially restrictly to the polar areas. It is expected that the results of this research will contribute to an understanding of one of the major surface features of both the Antarctic and the Arctic regions.

SUPPORTED BY U.S. National Science Foundation

3.0087, SEA ICE MOVEMENT DYNAMICS

N. UATERSTEINER, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

Evaluation of an existing mathematical model of sea ice movement with special emphasis on the term in the equation of motion representing the eddy viscosity of ice, and an elaboration of a plan to obtain empirical data necessary for a basic improvement of the model.

This project will aid in developing knowledge of the environmental factors that affect the polar ice fields and that is necessary for ice and topographic charting; ice predictions and allied purposes. The application of the model in forecasting ice concentration and movement showing open leads and pressure ridges will assist in routing of ships.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0088, ARCTIC AIR, SEA AND ICE

N. UNTERSTEINER, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

Coordinated micrometeorological investigations on shore at Barrow, Alaska, and on drifting stations establish qualitative and quantitative relationships of climate to the physical and biological phenomena it controls. Variables investigated are thermal, moisture and wind gradients, net radiation exchange and carbon dioxide of the atmosphere. Atmosphere and oceanographic factors are studied in their inter- relationships with the annual energy budget of ice, rate of ice formation and distribution information and drift and crystallographic structure.

This task contributes to knowledge of world-wide climatic circulation and specially to climatic patterns in the Arctic. Significant knowledge accrues on the earth's energy balance and the relationship of energy flux at water and atmospheric interfaces of ice to the growth, behavior and wastage of sea ice. Knowledge of total Arctic environments provide criteria for all Navy Arctic operations either by air, surface or water-ice approaches; safety and comfort of personnel; design of equipment; and for establishment of rational procedures. The interrelated studies furnish data essential for improved weather and ice forecasting.

SUPPORTED BY U.S. Dept. of Defense - Navy

3E. WEATHER MODIFICATION

3.0089, ION CLOUDS IN THE UPPER ATMOSPHERE

J.W. COOPER, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

Chemical seeding of the upper atmosphere with materials which form ion clouds has important military applications. The project aim is, as part of a cooperative effort involving scientists from a number of other installations, both in government and industry, (a) to investigate the feasibility of various proposals which have or are being made for chemical seeding and (b) to divide what areas of research and development are most likely to effectively improve the efficiency of chemical seeding processes. Both of these goals must be approached with specific applications in mind.

Work on this project consists mainly of maintaining a close contact with researchers who are actively engaged in chemical seeding technology or in closely related fields as well as those workers who intend to use such releases for specific applications. Detailed work consists in trying to determine what mechanisms are responsible for ionization in previously performed or proposed chemical releases.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

3.0090, PROJECT FOG DROPS

W.C. KOCMOND, Cornell Aeronautical Lab. Inc. , *Buffalo, New York* 14221

The purpose of Project Fog Drops is to investigate natural warm fog properties and dynamics and to suggest and evaluate concepts for modification of warm fogs. The principal accomplishments to date are summarized below.

A generalized fog classification system has been evolved. Structural models have been established for the micro-and macroscopic properties of advection and radiation fogs and for sea fog. A fog climatology has been established for the Continental United States.

Measurements made with the thermal diffusion chamber indicate that the maximum supersaturation achieved in urban fog is substantially less than 0.1 percent and that sources of atmospheric pollution are not the major contributors to the fog nucleus concentration.

Theoretical and experimental investigations have shown that the growth rates of droplets can be decreased by treatment of the droplets with certain surface active monolayers. Ionic surfactants were shown to inhibit rather than promote coalescence.

We have demonstrated in the laboratory that it is impractical to attempt to modify fog by placing electrical charge on the fog droplets. A procedure is currently being tested in the field for suppressing dense natural fog. Experiments in a 600 cubic meter cloud chamber have demonstrated that visibility in warm fog can be improved by a factor of up to 10 by seeding with hygroscopic nuclei of carefully controlled sizes.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4. SURVEY AND PREDICTION

4A. DATA NETWORKS

4.0001, SATELLITE COMMUNICATION TESTS

R.F. DEVEREUX, General Dynamics Corporation, *San Diego, California* (NONR)

The purpose of this task is to evaluate the use of synchronous satellite communication for telemetering oceanographic and meteorological data from moored oceanographic buoys, and to compare the method with the high frequency radio telemetry system now in use aboard the ONR monster buoys. To accomplish this a VHF system will be installed as an additional communication link aboard an existing monster buoy which will be anchored in the middle of the North Pacific in the summer of 1968. The data collected by the oceanographic and meteorological sensors will be stored in the buoy and transmitted, on command, from shore, by both VHF and HF radio links. Interrogation will be made from San Diego, California.

The capability of the Navy to make reliable predictions of the ocean environment for operations will depend in large part on synoptic ocean-wide networks of data collecting buoys. This task will provide experimental data important to the communication links necessary to such systems.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0002, OCEAN SYSTEM TELEMETRY STUDY

R.F. DEVEREUX, General Dynamics Corporation, *San Diego, California* (NONR)

A comparative engineering and economic analysis will be made of the use of moored surface buoy/radio links and ocean floor cabled systems for telemetering at remote locations both near and far from land masses. Applicable modulation, coding, data compaction transmission frequencies, subsurface cable characteristics, mooring techniques, reliability and costs are included in the study.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0003, NATIONAL DATA PROGRAM FOR THE MARINE ENVIRONMENT

J. SINGLETON, System Development Corporation, *Santa Monica, California*

This is a comprehensive ocean data management study intended to identify, formulate, and evaluate problems of information and data management associated with a national program for the development of the potential of the marine environment. The study should provide overall delineation of a preferred National Marine Data Program, including policy and operational arrangements, and specific priority steps for implementation.

Phase 1 of the task, completed in November 1967, was a 5-month project definition phase to determine the scope and structure of marine environmental data activities in the Federal and State governments, industry and universities. The 14-month Phase II will evaluate marine data and means for handling it; and design plans for a National Data Program for the Marine Environment.

SUPPORTED BY Natl. Council on Marine Res. & Engin. Dev.
U.S. Natl. Aero. & Space Adm.
U.S. National Science Foundation
U.S. Atomic Energy Commission
U.S. Dept. of Defense - Army
U.S. Dept. of Treasury
U.S. Dept. of Defense - Navy
U.S. Dept. of Interior
U.S. Dept. of Commerce
U.S. Dept. of Hlth. Ed. & Wel.

4.0004, STANDARD MONITORING SECTIONS (ATLANTIC AND PACIFIC OCEAN)

R.E. LENCZYK, U.S. Dept. of Transportation, Oceanographic Unit, *Washington, District of Columbia*

The oceanographic program on the Standard Monitoring Sections consists of the occupation (monthly and/or seasonal) of a line of oceanographic stations which are normal to a major current system. These sections, 7 in the Atlantic and 6 in the Pacific, were selected to include the most dynamic areas possible consistent with the normal tracks of the Ocean Station Vessels. The sections in the North Atlantic will provide considerable information about the Labrador and North Atlantic current systems. The North Pacific sections will provide information about the Kuroshio, North Pacific and California currents.

Serial observations are made of temperature and salinity to a depth of 1500 meters or to near bottom when the water depth is less than 1500 meters at each station and stations are taken at intervals that vary from 10 to 60 miles. Observations of temperature and salinity from each Nansen cast station are transmitted by radio teletype to the U. S. Coast Guard Oceanographic Unit for real-time processing, quality control and dissemination to users. During FY 69, the In Situ Salinity/ Temperature/Depth electronic measuring system (STD) is being introduced aboard the Atlantic and Pacific Ocean Station Vessels. This instrument will produce a continuous record of salinity and temperature versus depth and will be calibrated with simultaneous Nansen bottle data.

Data from these cruises are available at the National Oceanographic Data Center approximately two months following the cruise. These data with analyses will be published by the U. S. Coast Guard in the Oceanographic Report Series (CG-373).

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0005, TIME-SERIES OBSERVATIONS OF TEMPERATURE AND SALINITY (NORTH ATLANTIC AND NORTH PACIFIC OCEAN STATIONS)

R.E. LENCZYK, U.S. Dept. of Transportation, Oceanographic Unit, *Washington, District of Columbia*

The oceanographic program on the Ocean Stations consists of time- series observations of temperature and salinity. Nansen casts are made daily to 1500 meters in depth and once during the three week patrol to near bottom, weather and other operations permitting. Observations are made at 14 standard levels, the levels dependent upon historical data at each station. The temperature data is transmitted by radio teletype to the U. S. Coast Guard Oceanographic Unit for real- time processing, quality control, and dissemination to users. Salinities are determined at sea by the use of inductive salinometers. Salinity data are also transmitted by radio to the U. S. Coast Guard Oceanographic Unit for quality control. Occasionally, other observations are made by the OSVs, upon request, including biological sampling, collection of samples for chemical analyses, bathymetry, wave height measurements and others.

During FY-69, the use of an electronic measuring system was initiated on the Atlantic Ocean Stations. This instrument, the In Situ Salinity/Temperature/Depth Measuring System (STD), produced a continuous record of temperature and salinity versus depth. Observations are made to 1500 meters in depth four times daily. The STD observations are calibrated by simultaneous Nansen bottle observations. By the end of FY-69, it is expected that 75% of the Ocean Station Patrols in the Atlantic will be made using the STD system. Also the Pacific OSVs will be phasing in the STD instrument by this time.

Data from these cruises are available at the National Oceanographic Data Center approximately two months following the cruise. These data with analyses will be published by the U. S. Coast Guard in the Oceanographic Report Series (CG-373).

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0006, COAST GUARDS COASTAL OCEANOGRAPHIC MONITORNG NETWORK

M. LIGHT, U.S. Dept. of Transportation, Oceanographic Unit, *Washington, District of Columbia*

The Coast Guard presently maintains seven off-shore light stations and one large navigational sea buoy as replacements for lightships along the East Coast. Eventually all of the remaining 13 lightships will also be replaced by fixed aids-to-navigation. These fixed off- shore stations proved unique facilities for the continuous monitoring of the ocean environment. During the past 12 years the lightships and the fixed light stations have been used to monitor water temperatures and salinities with relatively unsophisticated instruments.

A prototype automatic oceanographic sensing and recording system was installed in December 1966 aboard the Buzzards Bay Light Station off Cuttyhunk Is., Mass. This system consists of four oceanographic sensor modules that precisely define in digital form five ocean parameters, and telemeters them through an inductive link to on-deck programming and data storage unit. Parameters measured include temperature, salinity, current speed, current direction, and depth.

In February 1967, a prototype oceanographic meteorological monitorying system was installed aboard the SCOTLAND Large Navigational Sea Buoy off Sandy Hook. The oceanographic transducer package is located approximately 5 feet below the water surface and measures the same parameters as the Buzzards Bay system. Its meteorological system measures air temperature, wind speed, wind direction, and barometric pressure. Digitized data are telemetered over the remote control and monitoring system for the on-board navigational equipment. The data are recorded automatically at Coast Guard Station, Sandy Hook on an incremental tape recorder. Typewritten printouts for real-time monitoring of data are also obtained on command.

The U. of Rhode Island Institute of Ocean Technology has a contract to provide for high order processing, analysis, and interpretation of data from both systems.

Data tapes produced by the Coastal Oceanographic Monitoring Network will be lodged with National Oceanographic Data Center. Monthly data reports will also be made available to the oceanographic community when these systems become operational.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0007, ENVIRONMENTAL MEASURING EQUIPMENT

R.P. COOK, U.S. Navy, Air Systems Command, *Washington, District of Columbia*

Objective: Develop environmental measuring equipment which will operate over extended periods and under adverse conditions to provide meteorological and oceanographic data over the now data-sparse polar and ocean areas. This equipment is designed to provide enough additional data to markedly enhance the techniques which are used to accurately predict those critical environmental factors which affect Naval operations.

Approach: Reduce the environment into arbitrary functional areas, such as: (1) Surface data for island and polar stations; (2) limited surface and subsurface data for marine stations; (3) full-range surface and subsurface data for marine stations, and (4) limited upper-air data for 2 and 3 above. Establish a best basic platform or mix of platforms for each functional area. Acquire, equip and test the platforms; and refine the various subsystems as necessary to show finite overall progress. Establish the best arrangement of marine platforms into a geographical array with the goal of achieving and operational network capable of acquiring and disseminating all of the environmental data affecting naval operations. Effort is coordinated with the USCG National Buoy Study.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0008, DEVELOPMENT EXPERIMENTAL SYSTEM FOR AIR SEA INTERACTIONS

M. GARSTANG, Florida State University, Graduate School, *Tallahassee, Florida* 32306

Over a planned three-year period, Florida State University, with major support from SAIL, is developing a buoy system for measurement of meteorological and oceanographic parameters. With ESSA ship and SAIL staff support, field investigations will be made over extended time periods in the vicinity of Barbados.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

4. SURVEY AND PREDICTION

4.0009, ANALYSIS AND INTERPRETATION OF SATELLITE RADIATION DATA

UNKNOWN, U.S. Natl. Aero. & Space Adm. , Goddard Space. Flgt. Ctr. , *Greenbelt, Maryland*

Technical Objective: To investigate the physical processes of the Earth-atmosphere system which affect the outgoing radiance over the parts of the spectrum sensed by the TIROS, Nimbus, and ATS radiation experiments, leading to methods of interpreting the data to consolidate the results of the experiments with theoretical concepts of atmospheric processes.

Approach: Analytical methods to determine the transfer of infrared and visible radiation in the atmosphere, through clouds, and at the Earth's surface are developed and applied to radiation measurements from meteorological satellites. These measurements are then interpreted in terms of the composition of the atmosphere, the global heat balance, and the general atmospheric circulation. In accomplishing these studies approximately five National Academy of Sciences - National Research Council Postdoctoral Resident Research Associates are supported along with the in-house civil service scientific staff, totalling some ten scientists. Because of the nature of this Work Unit, involving a concentration of activity largely having to do with multiple analyses of vast quantities of satellite data and the subsequent documentation of results, about 90% of the funds are required for computer programming, data handling, graphic services, visual arts, photographic, and publication support.

Progress: As of 26 January 1968, more than 7,000 individual orbits of radiation and spin-scan camera data have been acquired from satellites TIROS II, III, IV, and VII; Nimbus I and II; and ATS I and III. Many in-house studies of both a theoretical and empirical nature have been carried out to demonstrate the capability and potential of the measurements. Several of these studies have been reported, or brought nearly to completion during this reporting period.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0010, WEIR, TRAP AND SEINE FISHERY

A.E. PETERSON, State Div. of Marine Fisheries, *Boston, Massachusetts*

Objective: To obtain landing statistics, including location and gear, from weirs, fish traps, and seines.

Procedure: Weir and trap fishermen are required to submit monthly catch reports to the Director of the Division of Marine Fisheries. Catch reports would be required from seine operators landing their catch in Massachusetts. Interview sampling will be used to validate these reports.

Part 3 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Massachusetts State Government

4.0011, ANADROMOUS FISHERY

A.E. PETERSON, State Div. of Marine Fisheries, *Boston, Massachusetts*

Objective: To obtain accurate commercial landing statistics from the alewife fishways of the Commonwealth.

Procedure: All companies or individuals involved in commercial fishing for alewives in fishways of the Commonwealth will be required to submit weekly landing reports. It will be necessary to obtain a list of those individuals or companies involved in this fishery from the towns of the Commonwealth, since the leasing rights are vested in them. Interview sampling will be used to validify the catch reports.

Part 4 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Massachusetts State Government

4.0012, SHELLFISHERIES

A.E. PETERSON, State Div. of Marine Fisheries, *Boston, Massachusetts*

Objective: To obtain accurate commercial landing statistics, including location, catch, effort, and gear of the shellfisheries of the Commonwealth.

Procedure: Commerical shellfishermen are required to have a 'bed certificate' issued by the Director of Marine Fisheries in order to sell shellfish. As a requirement for obtaining a 'bed certificate', the fisherman will be required to submit a monthly catch report, stating species, amounts, location, and gear. Town shellfish officers will also be asked to submit monthly reports on landings for their towns. Stimulations for such reports from the officers can be made under the Division of Marine Fisheries' shellfish assistance program. A random sample, utilizing interviews, will be used to verify fisherman catch reports.

Part 5 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Massachusetts State Government

4.0013, OCEANOGRAPHIC DATA SYSTEMS

R.F. HILL, Univ. of Rhode Island, School of Engineering, *Kingston, Rhode Island* 02881

The development of techniques for the optimum design of total synoptic data systems on the basis of specific missions and under the constraint of cost.

SUPPORTED BY Raytheon Company

4.0014, DESIGN OF SAMPLING PLAN AND PROCUREMENT OF CHARTER VESSEL

E.B. JOSEPH, Virginia Inst. of Marine Sci. , *Gloucester Point, Virginia* 23062

The objective is to design a plan for exploratory bottom trawling on the Continental Shelf between Cape May, N. J. and Cape Hatteras, N. C. and to charter a vessel capable of executing the plan. Trawl stations will be spaced so as to sample representative bottom types and depths and to indicate the kinds, numbers, and distributional patterns of the fishes available to bottom trawls, with emphasis on those of potential industrial importance. Information obtained by interviewing trawlermen familiar with the area and by observing catches of trawlers fishing in the area will contribute to the plan. The plan will be designed to facilitate statistical analysis and machine processing of the data. Work will be accomplished in November and December, 1965.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Virginia State Government

4.0015, USES OF STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN FOR EFFICIENT COLLECTION OF OCEAN DATA

J.C. KELLEY, Univ. of Washington, Graduate School, *Seattle, Washington* 98122 (NONR)

Objective: In order to monitor and predict the environment, operational and research activities supported by the Navy must place measurement devices within and collect samples from the ocean. This research will provide the plan or design for a sampling program which meets, for minimal cost, the scientific and technological requirements stated as objectives by investigators directing Navy-sponsored ocean research.

Approach: This task makes extensive use of shore-based and shipboard digital computing equipment at the University of Washington. Under investigation are techniques to make available in easily understood graphical representations the state of available information at each state of a cruise. More efficient methods of data storage and retrieval are being developed. Using available field data and completed analyses of the data, estimates will be made of sampling error associated with a single data point. The results of the studies, together with state-of-the-art programming and statistical techniques, will be used to provide optimum sampling plans and costs for specific field experiments. The type of data to which this approach can be applied ranges from the mineral analyses of bottom samples to surface water temperatures.

SUPPORTED BY U.S. Dept. of Defense - Navy

4B. DATA PROCESSING AND ANALYSIS

4.0016, SYSTEM DESIGN STUDY FOR THE U.S. NAVAL OCEANOGRAPHIC OFFICE INTELLIGENCE DATA HANDLING SYSTEM

J.D. LITTLE, Planning Research Corporation, *Los Angeles, California*

PRC conducted a system analysis and design study for an automated data handling system for the U.S. Naval Oceanographic Office (NAVOCEANO) Mapping, Charting, and Geodetic Divisions. Current operations and future NAVOCEANO requirements were investigated in the areas of nautical and aeronautical charts and publications, and the handling and utilization of geodetic, gravimetric, magnetic, and hydrographic data.

The purpose of the study was to design a system which optimized the automation in handling both the source and reference information and materials used in graphic preparation. Data collection and reduction were performed, followed by the formulation of an operational concept and a time-phased system development plan. Interface requirements with all NAVOCEANO data interchange organizations were studied in order to maximize compatibility in information transfer and file formatting.

SUPPORTED BY U.S. Dept. of Defense - Air Force

4.0017, DATA COLLECTION

H. KLEIN, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038 (NONR)

This effort provides technicians trained to take observations independently, maintaining equipment, making measurements ashore of samples taken at sea, processing data, and producing data reports and charts. Procurement, calibration, and maintenance of much used instruments are carried on. Data processing is carried to the point of distribution as tables, charts, and diagrams adapted to the needs of different users.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0018, EVALUATION AND STATISTICAL ANALYSIS OF ALL DATA

T.P. RITCHIE, State Comm. on Shell Fisheries, *Dover, Delaware* 19901

The data obtained from the first three phases of this project will be evaluated by a qualified statistician. The new data that is obtained will be compared with the data available from Moore's survey in 1910. The net loss or gain in natural seed bed area will be documented and mapped. The uncharted hard bottom areas will be mapped in order to permanently establish the areas where future rehabilitation projects should be conducted.

Part 4 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Delaware State Government

4.0019, BIOMETRY

E. LUKACS, Catholic University of America, Graduate School, *Washington, District of Columbia* 20017 (NONR)

This task is concerned with the application of statistical methods to biological problems. The investigator and his staff consult with biologists in areas of mutual interest and provide advice and assistance on the design of experiments and the interpretation of mathematical results. Current emphasis is on new methods of statistical analysis of direction of movements and time periods involved in biological orientation. An attempt to develop new methods of multiple comparisons is being made where a sample range is used instead of ordered observations. This is especially useful in taxonomy and population variation.

This task is part of the program of oceanic biology and serves as a valuable analytic tool. It also serves in the translation of biological observations to mechanical and electronic equipment which the Navy requires for knowledge of such biological capabilities as homing, navigation, and avoidance and accurate integration of environmental clues.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0020, AUTOMATIC DATA PROCESSING - SEABIRD DISTRIBUTION

G.E. WATSON, Smithsonian Institution, *Washington, District of Columbia* 20560

Numerical codes for computer analysis have been devised for at- sea bird observations made during the Pacific Ocean Biological Survey Program so t that they may be computer analyzed. The International Seabird Committee has requested the Smithsonian Institution World Data Center and the Woods Hole Oceanographic Center to coordinate the storage and analysis of similar records on a world-wide basis. The first phase of this study will deal with adapting the POBSP codes for international use, devising a suitable nomenclature and code for seabirds of the world and establishing a uniform format for recording data. Later phases will deal with analyzing records.

SUPPORTED BY Smithsonian Institution

4.0021, FOSDIC APPLICATION TO CURRENT-METER RECORDS

M.L. GREENOUGH, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

The output films of certain commercially-made underwater recorders should be reducible by Government-owned scanners such as FOSDIC. It is the goal of this project to program the MOBIDIC - FOSDIC VI combination to scan these films, and to make the necessary modifications to its film-handling mechanism. It is expected that the use of this equipment will greatly reduce the cost of handling these records. As a programmable film reader, FOSDIC VI should be able to sense the multi-track lines so as to determine the direction of water flow. Velocity indication should be derived from counting the number of dots in groups on the films.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0022, ANALYSIS AND DISPLAY OF HYDROGRAPHIC DATA

R.L. WHEATLEY, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objective: Develop automatic cartographic compilation and reproduction techniques and equipment to reduce, by a factor of 2, the time required for base plant compilation and reproduction of charts in support of amphibious, port, and search/retrieve operation, as well as for general navigation purposes. Production of a chart presently requires six to nine months. This development will reduce the required lead time to three or four months for production of a chart. Coordinated development of components is scheduled through FY 73 to provide a logical sequential upgrading of functions. This effort is directed toward solving problems within the scope of mapping, charting, and geodetic functions as defined in the report, Effective Use of the Sea, June 1966, published by the panel on oceanography of the President's Science Advisory Committee.

Approach: In-house and contractual evaluation and studies of cartographic digital library functions, and of selected automatic digital compression and manipulation techniques and concepts for image and graphic data processing will be made. Hardware development will be directed toward automatic digitization of cartographic data and color separation functions and chart correction techniques. This will be followed by development of prototype automated correlation and mensuration techniques and equipment and a rapid graphic imaging and dissemination system. Evaluation of prototype components will provide the basis for development of an operational system.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0023, OCEANOGRAPHIC INFORMATION PROCESSING TECHNOLOGY

W.E. YERGEN, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

OBJECTIVE: Develop a 'Live Atlas' consisting of highly compacted oceanographic data which are retrievable in real-time from a master file through use of computers and which allow man interaction through use of CRT displays.

4. SURVEY AND PREDICTION

APPROACH: Compress voluminous National Oceanographic Data Center data files and unifying them into a master file using common geographical and chronological sorting parameters. Data are to be stored in binary format. The file will have an open end capability to allow addition of new data.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0024, ANALYZE AND PUBLISH BASIC DATA FROM PILOT STUDY

G.R. SECKEL, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Honolulu*, *Hawaii* 96812

Heat, salt, and momentum 'budgets' are t[illegible] the study to determine the mechanisms which change the distribution of properties and water masses in the trade wind zone. Using pilot study data analytical studies are undertaken to develop the necessary water 'budet' techniques. The feasibility of the investigation will be demonstrated in publications of the analytical studies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0025, DIGITAL RECORDING AND PROCESSING OF IN SITU DEPTH-TEMPERATURE-SALINITY DATA

V. GRAEFE, Univ. of Hawaii, Hawaii Inst. of Geophysics, *Honolulu*, *Hawaii* 96822

A commercially manufactured depth-temperature-salinity recorder (DTS) is being used by the Department of Oceanography. It presents the measured data in the form of a graph of temperature and salinity versus depth. Digitizing equipment has been developed which transforms the telemetry signals produced by the DTS system into digital values of the three variables and records these on a teletypewriter. Simultaneously the values are punched on paper tape for later computer processing and they are also transmitted via a radio-teletypewriter link to the HIG for immediate processing. The data are then checked on an IBM 1401 computer for errors which might have been introduced by slipring noise or malfunction of the teleprinters. To some extent these errors are corrected automatically, while other errors have to be corrected by hand. The data are then smoothed, freed from systematic errors, and punched on cards in a standardized format on an IBM 360/50 computer. These cards contain one value each for temperature and salinity for every two meters of depth; the values are believed to be correct to plus or minus 0.002 degrees C (temperature) and 0.03% (salinity). Other programs have been written which use these cards to compute--among others--density, dynamic height, and sound velocity values--and which present derived as well as observed quantities in graphic and numerical form.

The two-meter data cards are made available to the NODC.

SUPPORTED BY University of Hawaii

4.0026, PHYSICAL AND CHEMICAL ATLAS

K. WYRTKI, Univ. of Hawaii, Graduate School, *Honolulu*, *Hawaii* 96822

This grant is for continued preparation of the physical and chemical oceanographic atlas resulting from the International Indian Ocean Expedition. The atlas will be in two parts: Part I will contain the distribution of physical and chemical properties at selected levels and along specific sections of the ocean. Part II will consist of an analysis of all data submitted to World Data Center A, including property distribution, core layer analysis, oxygen, minima and maxima, phosphates, bottom temperature, depth of the mixed layer and intensity of thermocline.

SUPPORTED BY U.S. National Science Foundation

4.0027, RESEARCH IN MARINE GEOLOGY

A.F. RICHARDS, Univ. of Illinois, Graduate School, *Urbana*, *Illinois*

The primary objective of this research is to complete the data reduction, interpretation, and publication of results obtained on the 1966 cruise of the OCEANOGRAPHER (OPR-470).

To analyze and prepare for publication the seismic profiles, magnetics and gravity data.

The bathymetry, magnetics, gravity, and reflection seismic profiles have been compiled in the form of charts and profiles.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

4.0028, ANALYTICAL OCEANOGRAPHY

R.B. MONTGOMERY, Johns Hopkins University, Graduate School, *Baltimore*, *Maryland* 21218 (NONR)

The purpose of this work is to develop improved procedures for the analysis and presentation of serial oceanographic data and also to utilize these procedures in the analysis of existing data to attain better descriptions of oceanic structure. Sets of oceanographic stations from the six oceans are being summarized and graphic presented; temporal variations of temperature, salinity and oxygen from 1500 to 4000 meters as observed at Weather Station PAPA are being analyzed; and studies of the Gulf Stream and Mindanao Current are being made.

The proper analysis of oceanographic data and synthesis of a clear picture of oceanic structure is essential for a clear understanding of the environment. The results from this task contribute both to better description and understanding of the ocean environment and the development of techniques that are useful to survey programs.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0029, DISSEMINATION OF COMMERCIAL FISHERIES STATISTICS

A.E. PETERSON, State Div. of Marine Fisheries, *Boston*, *Massachusetts*

Objectives: To disseminate statistics in monthly bulletins in cooperation with the Bureau of Commercial Fisheries.

Procedures: The catch statistics will be compiled under the phases listed above. After evaluation and application of various descriptive statistics, the data will be submitted to the Bureau of Commercial Fisheries, to be published in cooperation with the monthly 'Massachusetts Landings' bulletin.

Location: Boston, Massachusetts, and throughout the Commonwealth as required.

Part 6 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Massachusetts State Government

4.0030, GRAVITY AND MAGNETIC DATA COLLECTED DURING THE INTERNATIONAL INDIAN OCEAN EXPEDITION AND IN THE CARIBBEAN SEA

C.O. BOWIN, Woods Hole Oceanographic Inst. , *Woods Hole*, *Massachusetts* 02543

A vast amount of geophysical data has been collected during the several cruises of the R/V CHAIN and R/V ATLANTIS II into the Indian Ocean. The purpose of this study is to analyze and interpret the gravity and magnetic data obtained on the geophysical cruises to the Indian Ocean, Red Sea, Mediterranean Sea, Atlantic Ocean and the regions around Hispaniola. The research will be conducted primarily by means of using new programming methods on digital computer equipment. Important steps in the analysis of the information are reduction of the raw data, reprocessing, testing, and plotting maps and profiles. The comparison of calculated gravity anomalies from model crustal structure profiles with observed values will also be undertaken as it has great promise as a means of exploring the oceanic crust.

SUPPORTED BY U.S. National Science Foundation

4.0031, WOODS HOLE SHIPBOARD DATA PROCESSING

E.E. HAYS, Woods Hole Oceanographic Inst. , *Woods Hole*, *Massachusetts* 02543 (NONR)

Objective: To carry out real time oceanographic data processing, computation, and plotting required for reporting oceanic phenomena.

Approach: Continue the development of a computer system aboard CHAIN centered about the Hewlett-Packard 2116A digital computer to produce a real time system for acquisition, reduction, recording, and display for navigation, gravity, and magnetic information.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0032, ACQUISITION, REDUCTION AND INTERPRETATION OF MARINE MAGNETIC DATA

J.R. HEIRTZLER, Columbia University, Graduate School, *New York, New York* 10027

The purpose of this research project is to continue the acquistion, reduction and interpretation of marine magnetic data from one ship over a two-year period. Digital computer processing and plotting methods, operational since August 1964, now make it possible to keep pace with data acquisition.

It is important that area studies be continued. Large provinces with linear magnetic patterns have been found off the east and west coasts of North America. Long linear magnetic anomalies have been associated with the Atlantic mid-oceanic ridge system. As the density

interpretation in other areas such as the East Pacific-Antarctic pacific mid-oceanic ridge system, the Argentine shelf and the West African shlf, becomes feasible.

SUPPORTED BY U.S. National Science Foundation

4.0033, ACQUISITION AND INTERPRETATION OF OCEANIC GRAVITY DATA

J.L. WORZEL, Columbia University, Graduate School, *New York, New York* 10027

The present analog cross coupling computer used to apply corrections to gravity values will be improved and studies of nonlinearity of the gravity meter in the presence of large vertical ship accelerations will be carried out. An analog will be built and analog equipment to correct for slow response of gravity meter will be constructed. Also, under this grant, existing computer techniques for rapid data processing will be extended and improved.

Studies will be made of the crustal structure of Mid-Ocean Ridges, Deep Sea Trenches, Continental Margins, Seamounts, etc. The basic technique will involve combining gravity data with available magnetic and seismic information.

SUPPORTED BY U.S. National Science Foundation

4.0034, INDIAN OCEAN DATA REDUCTION

EWING, Columbia University, Graduate School, *Palisades, New York* 10964

The major objective of this study is to analyze in detail the data collected during the International Ocean Expedition. The Lamont Geological Observatory has gathered data in the Indian Ocean on the R/V VEMA and the R/V CONRAD during the field operations of the Expedition and the data recovered from these cruises have been worked up in a preliminary manner aboard the ship to assure that the data is of good quality. Upon returning to the laboratory, these data must be further reduced as the preliminary operations do not cover all the possible corrections and information. It is planned, insofar as possible, to analyze these data in conjunction with each other and not to attempt to analyze them as completely separate studies. The work will include studies on bathymetry, geophysics, geochemistry, sedimentology, physical oceanography, bottom photographs and biology.

The reading, plotting and profiling of soundings obtained by R/V VEMA, R/V CONRAD and R/V ANTON BRUUN of several detailed areas where data are particularly concentrated will be completed. The preparation of diagrams, profiles, maps, tables, etc., showing the distribution of the geological, geophysical and topographic characteristics of the Indian Ocean will be prepared for a monograph to accompany the physiographic diagram of the Indian Ocean. An emphasis will be placed on evaluation of the geophysical data, (gravity, seismic, magnetic and heat flow measurements) in conjunction with the bathymetry for the purpose of elucidating the structure of the Indian Ocean basin.

SUPPORTED BY U.S. National Science Foundation

4.0035, OCEAN BOTTOM EMPLACED GEOPHYSICAL STATION

M. EWING, Columbia University, Graduate School, *Palisades, New York* 10964

The principal investigators have been engaged in the design, development, and installation of an ocean bottom geophysical station since 1963. The present observatory was placed on the ocean floor approximately 200 km west of San Francisco at a depth of 3.9 km in May 1966 and has operated with a high degree of reliability since that time.

The primary elements of the ocean bottom instrument are: 1) a three-component set of pendulums with 15-sec natural periods; 2) a three-component set of pendulums with natural periods of 1 sec; 3) two hydrophones; 4) a vibrotron pressure transducer; 5) a water temperature senser; 6) a current magnitude sensor; and 7) a current direction sensor.

Data are transmitted by cable to the recording station at Point Arena, California. The demodulated signal is recorded on magnetic tape, strip chart recorders, and photographic drum recorders at the Point Arena station. A three-component set of short-period seismometers and a wave recorder are presently in operation at the Point Arena recording station.

The experiment has thus far returned 18 months of data from the ocean bottom at a total cost of 1.2 million dollars. While this expense may seem large, it must be weighed against the large number of important contributions which have been made in a variety of fields.

This proposal is for: 1) the operation and maintenance of the recording station at Point Arena, California, and 2) support of a data analysis program.

SUPPORTED BY U.S. National Science Foundation

4.0036, A SHIPBOARD DIGITAL DATA ACQUISITION SYSTEM

R.A. BRODING, Seismograph Service Corp. , *Tulsa, Oklahoma*

Summary: A digital system was developed for shipboard acquisition of exploration data that makes use of a small, high-speed computer for formatting, compositing and system control. A 4,096-16 bit core and a 6 million bit disc are used for storage. Dual tape decks provide for continuous operation as well as auxiliary operations, such as tape- to-tape transfer, editing and off-line computing. Typically, 24 channels of seismic data are quantized at 1, 2, 4 or 8 millisecond sample rates. Computer input is via multiplexer, magnetic tape, paper tape or teletype keyboard. Output is on standard 1/2' magnetic tape 800 bpi 9 channel, paper tape or teletype print-out. A control panel for the system permits digit switch entry of certain operational parameters such as listen time, dead time and number of composites. Software includes programs for acquisition routines in a continuous mode or externally triggered from the ship's clock. Each data record contains a header that includes all the operational parameters. Monitoring of the system is by storage oscilloscope, 25-channel oscillograph and section plotter. Twenty-four 13-bit DACs provide for monitoring the system either before or after recording. An on-line magnetic tape correlator provides the signal from any one seismometer station to the plotter. Thus, a continuous set of diagnostics provide for checking selected station. A complete set of diagnostics provide for checking all of the major elements in the system as well as the programs.

SUPPORTED BY Seismograph Service Corporation

4.0037, SURVEY, EVALUATION & SUMMARIZATION OF LITERATURE ON ENVIRONMENTAL REQUIREMENTS OF MARINE ORGANISMS LEVELS OF POTENTIAL TOXICANTS (ABBREV

C.M. TARZWELL, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab. , *Wakefield - Kingston, Rhode Island* 02881

It is proposed that each of the sections and the units within the section will deal with those parts of the literature which are pertinent to their work. All papers will be abstracted, a summary given as to the significance of the paper, and key words developed so that the paper and the abstract can be fitted into a data retrieval system. It is planned to do this for current literature, and to contract work on past literature in order to build up a library for use at the National Marine Water Quality Laboratory and elsewhere in the research program for the development of water quality criteria.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

4. SURVEY AND PREDICTION

4.0038, MARINE DIGITAL GRAVITY PROFILING SYSTEM

J.K. PAWLEY, Teledyne Incorporated, *Houston, Texas* 77036

Specify and implement a coordinated digital hardware-software system for gravity profiling at sea. The critical requirement of resolution of ship velocity to 0.1 knot is to be met by continuous recording of radiolocation data plus statistical processing.

SUPPORTED BY Teledyne Exploration Company

4.0039, DIGITIZING SYSTEM FOR OCEANOGRAPHIC DATA

J.S. CREAGER, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

Acquisition of a on-board graphical-to-digital data conversion system is needed to convert graphically recorded data including continuous seismic reflection profiles, in situ acoustic absorption records, precision depth recordings, and records for frequency spectral analysis of scattering layers. Also, even though a graphical-to-digital data conversion facility will soon be available on the University campus, the Department of Oceanography feels that previously recorded analogue records are comparable to currently recorded records only if they are digitized on the same device. Quality control is possible only with the specified equipment.

SUPPORTED BY U.S. National Science Foundation

4C. ENVIRONMENTAL PREDICTION

(see Also Chapter 3, Meteorology)

4.0040, FIORD OCEANOGRAPHY

J.B. MATTHEWS, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735 (NONR)

The objective of this task is the prediction of oceanographic parameters of fiord type estuaries. This will be accomplished by evaluating field data in conjunction with the hydrodynamic equations and from this information form a numerical model which will predict the parameters. During the coming year a concentrated effort to sample those parameters necessary to establish a simple numerical model will be undertaken in Endicott Arm estuary. Measurement techniques will include moored current meters, tide gauges, and shipboard sampling.

This work is of interest to the Navy because very little is known about the oceanography of this region of the United States. In addition, the fiords of Southeast Alaska are typical of those throughout the world and our increased knowledge of the oceanographic processes taking place there will have universal application.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0041, NUMERICAL PREDICTION

P.M. WOLFF, U.S. Navy, Fleet Numerical Weather Facil., *Monterey, California* 93940

Objectives: The success of a military operation may well depend on intelligent understanding of the natural environment within which the operation takes place. The requirement exists for the determination and display of the expected values of critical environmental variable both in time and space. This must be accomplished for various projected (future) time periods. This task supports exploratory development of techniques to provide the navy with timely and accurate forecasts of weather, both oceanographic and meteorological.

Approach: To cope with the enormity of the problem and provide forecasts in a time frame to insure their maximum usefulness this task area is automating the complete forecasting cycle which consists of data processing, data analysis, preparation of forecasts, rapid dissemination and dissemination and display of the final product. Automation is achieved through the use of computers and high speed communications networks.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0042, OBJECTIVE WEATHER ANALYSIS

H.A. BEDIENT, U.S. Dept. of Commerce, Natl. Meteorological Ctr. , *Washington, District of Columbia* 20233

Objective - The objectives are to develop improvements to the analysis of data required for numerical weather prediction.

Approach - Work is being done to improve analysis on a tropical strip from 48 degree N to 48 degree S around the earth. Additional work will be done to incorporate heights in the tropical analysis as described by Bedient in NMC Office Note No. 21. The technique of Office Note No. 21 is being developed and tested for the NMC octagon grid. Tests are being made to incorporate the Offutt gradient wind system as an alternative to the preceding method. Work is being done on improvement of the 250 mb analysis.

Progress - Some tests were being made with the solution of the balance equation across the equator. The tests of Office Note No. 21 in the tropics have been combined with the high latitude analysis and will be done together. Complete coding was done on a procedure for the octagon to carry out the proposal of Office Note No. 21. One run was successfully made through the whole procedure. Results were encouraging but accumulation of integration errors cause a new look to be taken at the procedure. This is being reprogrammed and work will continue through the rest of the year. The 250 mb analysis was put into operation during the period; results seemed to be good. Further study is being made to determine improvements. The gradient wind analysis modification has been programmed and tests will be made on the procedure during the next period.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

4.0043, LARGE-SCALE ATMOSPHERIC EVOLUTION

J. NAMIAS, U.S. Dept. of Commerce, Natl. Meteorological Ctr. , *Washington, District of Columbia* 20233

Objective - The objective is to apply physical principles governing the evolution of the atmosphere and oceans to the prediction of sea temperature, storminess, and weather changes for periods of a month or longer.

Approach - The objectives are approached through study of the energy balance of the atmosphere, land and oceans, and the exchange of energy between them, in relation to such things as anomalies in ocean temperature, snow, and ice cover. Acquired knowledge is included in physical models for numerically predicting the evolution of monthly- mean states of the atmosphere and ocean. Access to electronic computers and close coordination with other research in numerical weather prediction is essential for progress.

Progress - In the year ending June 30, 1967, the study of the northeastern United States drought was concluded. It led to a more general study of seasonal precipitation in this region related to that in other states. New emphasis is on ocean-atmosphere interactions over the Pacific Ocean. Tests and evaluations continue on numerical models for predicting mean rainfall, and temperature in the atmosphere and ocean for a month in advance. Work now centers on developing an improved model which can incorporate already-formulated better estimates of the mean water budget of the atmosphere, horizontal heat transfer in atmosphere and ocean, and reflectivity of the earth's surface.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

4.0044, MAGNETIC AND GRAVITY PREDICTION

J.A. BRENNAN, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

OBJECTIVES: Determine the affect of magnetic storms and micropulsation activity on present and future magnetic sensors. This effort is directed toward reducing or eliminating this source of noise.

APPROACH: A magnetic recording station will be established in order that very sensitive magnetic data can be acquired. Noise will be catalogued as to frequency of occurrences, amplitude, and coherence with effects on fleet equipment. The observed station data and fleet effects will be further correlated with standard geomagnetic 'K' and 'A' indexes. An attempt will be made to define magnetic activity in terms of a magnetic activity index.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0045, WEATHER ANALYSIS AND FORECASTING TECHNIQUES

A.F. PYLE, U.S. Navy, Air Systems Command, *Washington, District of Columbia*

Objective: To develop new or more efficient techniques for analyzing and forecasting environmental factors; to establish the influence of these environmental factors on naval operations and to develop efficient systems for display and presentation of environmental data that will ensure optimum comprehension by the user.

Approach: Development of new and improved prediction techniques is largely based on new knowledge resulting from research in the atmospheric and oceanographic sciences. To bridge the process from research to exploratory development specially qualified personnel at the naval weather research facility and a few select contractors are employed. Developed techniques are tested and evaluated and if successful are either placed into operational use or, if required, go into advanced development.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0046, GLOBAL OCEAN FLOOR ANALYSIS

E.D. SCHNEIDER, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

OBJECTIVES: To improve Navy capability to describe, understand, predict and ultimately utilize geological and geophysical parameters of the ocean floor in support of NAVOCEANO's mission of providing pertinent and vital environmental information for the operating forces.

APPROACH: Collect geophysical and sub-bottom acoustic profiles; analyze them in reference to physical, particulate, and chemical properties. Integrate these data into a physiographic and structural charting program permitting predictive determination of limits and areal extent of specific acoustic absorption and attenuation characteristics. Correlate bottom current effects, magnetic and stratigraphic patterns, sediment properties, and physiographic features with respect to more rapidly collectable bathymetric data.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0047, INVENTORY OF THE GULF ESTUARY SYSTEM

N.G. VICK, U.S. Dept. of Interior, Bureau of Sport Fish. & Wlfe., *Panama City, Florida* 32401

The objectives of this study unit are to procure and document environmental and ecological data on the St. Andrew Bay System, Panama City, Florida. These data will include (1) area descriptions (2) hydrology of the bay system (3) sedimentology, and (4) samples of the biological materials available seasonally with emphasis on the sporting species of marine fishes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0048, PREDICTION OF EXTREME ENVIRONMENTAL FACTORS

N. BUSKE, Ocean Science & Engin. Inc., *Bethesda, Maryland* 20014

Dimensional analyses of factors associated with extreme winds and extreme waves. Development of universal prediction method for extreme wind or wave occurrances.

SUPPORTED BY Ocean Science & Engineering Incorporated

4.0049, ARCTIC RESEARCH

K.L. HUNKINS, Columbia University, Graduate School, *Palisades, New York* 10964

The objective of this research program is to understand (1) the topography, crustal structure, and sediment regime within the Arctic Ocean basin, (2) the motions of Arctic ice and water, and (3) the acoustic properties of the Arctic Ocean. Measurements are made on a year-round basis from Fletcher's Ice Island, T-3, to provide information on geographic position, depth, sub-bottom reflections, bottom sediments, gravity and magnetic field strengths, currents, and sound-scattering layers.

Operations within the Arctic Ocean require information on bottom topography, ice and water motions, deflections of the vertical, magnetic anomalies, and acoustic propagation and scattering layers in order to navigate more safely and perform effectively. This program will provide pertinent information efficiently and economically in an area where surface ships cannot operate.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0050, OCEANOGRAPHIC PROCESSES IN ESTUARINE AND COASTAL WATERS

C.A. BARNES, Univ. of Washington, Graduate School, *Seattle, Washington* 98122 (NONR)

Objective: In order to describe and predict the operating environmental conditions for its forces in estuarine and coast areas of the world, the Navy must have an understanding of the physical processes influencing and controlling these environments. This research effort is to produce a better understanding of the small scale variations in the physical characteristics and circulation of the waters in a variety of estuaries.

Approach: A field program is being conducted in the Puget Sound region and its approaches and in the waters of the Pacific Ocean bordering the State of Washington. A series of temperature, salinity, density, sound-velocity, oxygen and current velocity measurements are being made to assess the role of thin lens water parcels injected into Dabob Bay upon the properties and structure of the waters in that estuary. Analysis also will be made on the vertical oscillations of the depth of the region of maximum density gradient to determine the dependence upon tide height, mean water level, barometric pressure and wind stress.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0051, DISTRIBUTIONS OF CURRENTS AND PHYSICAL PROPERTIES WITHIN THE ARCTIC OCEAN

L.K. COACHMAN, Univ. of Washington, Graduate School, *Seattle, Washington* 98122 (NONR)

Objective: A thorough knowledge of the Arctic Ocean and its adjacent seas is of fundamental importance to naval operations in the area. This research supports that objective. Among the aspects of this work which are of particular significance to the Navy are: (1) discovery and measurement of swift, time-dependent currents in the operational region of submarines; (2) distribution of super cooled water which may affect navigation and icing under surface ice; (3) the distribution of water which may affect navigation and icing under surface ice; (4) monitoring oceanographic literature (particularly Soviet) of the Arctic; (5) measurement of surface currents in Bering- Chukchi Sea, Greenland-Norwegian Sea and Baffin Bay, which are important to navigation and ice distribution in these peripheral areas; and (6) studies of heat exchange across the air-sea surface which are important to arctic meteorology and ice prediction.

Approach: The work is conducted by: literature monitoring; laboratory work continuing the analyses of water masses; the development of theoretical models; and field observations conducted from the ice island T-3 and available vessels. In the central arctic basin a program to study motions and water properties will continue from T-3. Utilizing ships of opportunity, in cooperation with the U. S. Coast Guard, and current meters suspended from buoys the flow through the Bering Strait will be measured as a function of time. Programs are underway to investigate numerically (1) the wind-induced circulation in the Greenland and Bering Seas, and (2) the effects of bottom topography on currents in the Arctic.

SUPPORTED BY U.S. Dept. of Defense - Navy

4D. MAPPING, CHARTING, AND GEODESY

4.0052, LOCATING AND MAPPING HARD BOTTOM AREAS NEAR EXISTING NATURAL SEED OYSTER BEDS

T.P. RITCHIE, State Comm. on Shell Fisheries, *Dover, Delaware* 19901

The objective of this phase is to determine the location and acre extent of hard bottom areas which could be used to create new oyster seed beds. Preliminary surveys indicate that high salinities now prevail over many of our formerly productive seed oyster beds. Spat bags indicate that oysters will set and survive in areas where oyster shells are totally lacking on the bottom. Our objective is to determine the size and shape of hard bottom areas that we may have to use in the future.

Some indication of bottom hardness can be obtained by use of a fine-line depth recorder. Several oyster shell dredging companies routinely use these instruments to determine the extent of sub-surface oyster shell deposits. The actual bottom consistency will be determined by grab samples and by use of a sounding pole.

Part 3 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Delaware State Government

4.0053, PHOTOGRAPHIC IMAGE EVALUATION

D.R. LEHMBECK, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

To study human evaluation and machine measurement of the qualities of photographic images.

Objective measures of photographic noise and photographic signals which will be useful correlates of subjective impressions of photographic quality are being explored, as are the interactions of photographic film with optical systems. The automation of measurements of acutance, granularity, and modulation transfer function and means of making such measurements more precise and repeatable are being considered.

The microdensitometers are undergoing modification, calibration, and repair. Output data is recorded in digital form on magnetic tape for use on a computer programmed to analyze the information. A program for acutance is in final form and needs to be checked using data from know acutance standards. A granularity program is being 'debugged'. Programs for modulation transfer function measurements and other forms of modern Fourier analysis are being considered. Once these well known measurements can be automatically made, it is planned to study the validity of the measurements, to attempt to isolate variables affecting interlaboratory comparisons, and to modify the methods to improve correlation with subjective judgements of quality. New image evaluation methods can then be explored. We are investigating the factors which affect the measurement of microdensity, particularly, the effects of numerical aperature of measuring optics.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0054, TEKTITE I

H.E. CLIFTON, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

This project is investigating the efficacy of pursuing geologic mapping of the sea floor and the study of geologic processes operating there, utilizing an undersea habitat and saturation diving techniques. A geologist, in company with several marine biologists, will spend 60 days continually submerged, working from a habitat at 60' depth off the coast of the Virgin Islands. This project is being carried out in cooperation with Bureau of Commercial Fisheries, Navy Department, NASA, Bureau of Mines and General Electric Corporation.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0055, BOTTOM TOPOGRAPHY AND SEDIMENTS—MIDDLE ATLANTIC SHELF

F. STEARNS, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Washington, District of Columbia*

Mapping of bottom topography and sediments of the Middle Atlantic Continental Shelf region of eastern North America. The principal source of data is the Coast and Geodetic Survey.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0056, WORLD WIDE MARINE MINERAL RESOURCES

F.H. WANG, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

To prepare maps at various scales of the world's continental margins and deep oceans and ultimately to accumulate and computerize data on location and quality of marine mineral and related resources for evaluation of the world's real and potential mineral resources.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0057, OYSTER LEASE CONTROL MONUMENTS - BAY ADAM, BASTIAN BAY AND SANDY POINT BAY AREAS

J.W. LAY, State Wildlife & Fish Comm. , *New Orleans, Louisiana*

Objectives: The overall objective is to establish control monuments throughout the oyster growing areas of coastal Louisiana at 1/2 mile spacings on the land from which surveys of waterbottoms for oyster leases could be coordinated as a specific reference point. This work will be performed on a compartmental basis, working in each particular area until the job is completed as permitted by weather and tidal conditions. Each area will be selected on the basis of the greatest need; however, proximity of such areas will be carefully coordinated insofar as possible.

Procedure and Work Schedule - 1. Monuments are to be set in place around the bays at approximately 1/2 mile spacings. 2. A Traverse Line will then be run, beginning from a known location of a U. S. C. G. Triangulation Station and joining all monuments together, and then tied into another U.S.C.G.S. Triangulation Station. 3. All oyster leases will then be tied into the designated base line monument.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Louisiana State Government

4.0058, MARINE PHYSICAL GEODESY

W. VONARX, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

The objectives of this program are to (a) continue development of marine geodetic instrumentation, (b) define the geoid at sea, (c) measure departures of the physical sea surface from the geoid, and (d) interpret these departures in terms of the meteorological, tidal and ocean current forces which cause them. During this contract year VLF range rate information will be integrated into a satellite navigational receiver system. This is expected to improve geographic positioning accuracy to the astronomical positioning accuracy of about 6 seconds of arc presently available with GEON. Development of an improved theodolite for use on GEON will continue. Astrogravimetric arcs will be run in significant areas such as the Florida Straits as opportunities arise.

The accuracy of inertial navigation systems is limited by insufficient knowledge about the earth's gravity field and deflections of the vertical. In support of the Navy's effort to remove this limitation, this program is developing and evaluating new techniques and instruments in the fields of navigation and marine gravimetry; providing direct measurements of deflections of the vertical at sea; and obtaining marine gravity data.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0059, OCEANOGRAPHY ATLAS OF THE NORTH CAROLINA CONTINENTAL MARGIN

O.H. PILKEY, Duke University, Graduate School, *Beaufort, North Carolina* 28516

00NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY North Carolina State Government

4.0060, DEVELOPMENT OF A PHOTOGRAPHIC SUIT FOR STEREOPHOTOGRAMMETRIC MAPPING BY SUMBERSIBLE

G.F. BASS, Univ. of Pennsylvania, Graduate School, *Philadelphia, Pennsylvania* 19104 (N00014-67-A-0216-0002)

The objective of this task is to develop, construct and evaluate stereophotogrammetric equipment for underwater mapping and to evaluate scanning sonar techniques and transponder navigation systems for underwater search. The evaluations will be made during an underwater archeological expedition off the coast of Turkey.

The present efforts of the Navy to use deep diving submarines for search and rescue are hampered by our lack of ability to navigate and map underwater. The results of this study should improve our capability in this field.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0061, FEASIBILITY STUDY FOR SYNTHETIC APERTURE ARRAY ACOUSTIC BOTTOM MAPPING SYSTEM

G.M. WALSH, Unknown, *Rhode Island*

The application of the synthetic aperture array principle to a high resolution, ocean bottom mapping system is shown to be feasible for practical and useful system operating parameters. The basic operating parameter relations for the synthetic array system are derived. The requirements for vehicle and propagating medium stability are defined. Experimental evidence, although not directly applicable, indicates that medium stability is adequate for practical system designs. Vehicle motion sensing can be adequately performed by a combination of an inertial platform and an acoustic doppler 'clutterlock' system. An important consideration is the signal-to volume reverberation level, which limits the maximum PRF. A system design is presented using a digital signal processor, and including budgetary cost estimates. Possible extensions to the basic system include narrow multiple beam coverage under the ship track, shallow sub-bottom profiling, and precision short term local navigation. The importance of other data inputs to the interpretation of the geological features of the imagery is discussed.

SUPPORTED BY Raytheon Company

4.0062, GALVESTON BAY STUDY

W.H. ESPEY, Tracor Incorporated, *Austin, Texas* 78721

TRACOR, Inc. is responsible for the development of computer models and a data storage and retrieval system for the Galveston Bay Study. Computer models are being developed which describe the hydrologic, chemical, and biological responses of the estuarine system. The models will predict the water quality characteristics at various points in the bay as defined by various boundary and input conditions. The two- dimensional hydraulic model will predict spatial and temporal distribution of tides, velocities (magnitude and direction) and phasing between tides and velocities in response to tidal action, wind stress, fresh water flows, physiographic features, etc., by the numerical solution of the Navier-Stokes and continuity equations.

The transport characteristics of the bay system are being incorporated into the water quality models to allow the temporal and spatial variations of mixing and exchange of Gulf waters throughout the bay system. The models will be sufficiently flexible to permit evaluation of water quality and assimilative capacity under a variety of levels of waste treatment and methods of waste treatment.

Results of the evaluation of various alternative waste treatment systems will define the input to the optimization model. This model will provide a quantitative framework from which to determine the most cost-effective system in terms of design, operation, and various legal- institutional constraints to achieve optimum use of the Bay resources.

SUPPORTED BY Texas State Government

4E. MODEL STUDIES

(General Construction and Application. Models of Specific Systems Found Under that Subject.)

4.0063, SIMULATION MODEL FOR THE ANALYSIS OF ADVANCED MARINE SHIPPING SYSTEMS

UNKNOWN, Univ. of California, Graduate School, *Berkeley, California* 94720

PURPOSE: To explore the applicability of modular transportation computer simulation, TRANSIM, for analyzing advanced marine shipping systems.

DESCRIPTION: The TRANSIM transportation system simulator was developed by the University of California to fill the need for a general purpose computer simulation method which is simple and economical to use in a wide variety of transportation problems. The objective was to develop a method by which problem formulation, model structuring, and setting up the simulation could be accomplished by individuals who are not necessarily familiar with programming and computers.

This research study will analyze a high speed shuttle ship system and a detachable power plant system. Results will determine: (1) the complexity of TRANSIM's use with problem formulation, model structuring, organization of data input, and in general, setting up the computer simulation; (2) the flexibility and type of computer output as to ease of analysis format, and altering; (3) the costs and manhours associated with the use of TRANSIM; (4) the applicability for future, more complex simulations.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

4.0064, COMPETITIVE MERCHAND SHIP (BULK) TECHNICAL INNOVATIONS

UNKNOWN, Litton Industries Incorporated, *Culver City, California*

Purpose: To forecast the technical innovation climate for bulk carriers in support of preparation of a plan for producing advanced dry bulk shipping systems.

Description: Technical and economic analyses of innovations which could be included in new bulk carriers to maximize returns to the owners and to the Government will be carried out. The research will provide a means of evaluating; different ship sizes and types, advanced equipment, methods of construction, innovations in the design process, and the value of ship standardization.

An analytical model will be developed to evaluate technical concepts. The results will serve as input to the development of a Strategic Development Plan for producing competitive bulk carriers.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

4.0065, MULTISPECIES FISHERIES MODELS

W. LENARZ, U.S. Dept. of Interior, Fishery Oceanography Ctr., *La Jolla, California*

The pelagic fisheries of California are based on a multispecies ecosystem. Because of the nature of the oceanographic climate, the ecosystem is unlikely to remain in a stable equilibrium, even in the absence of a fishery. To assist our understanding of the likely consequences of fishing effort and climatic change on such an ecosystem, we must be able to interpret our findings in terms of the theoretical multispecies fisheries models currently being developed elsewhere and to construct a model (perhaps by computer simulation studies) relevant to California fisheries.

This project was initiated in FY 1969 with the recruitment of the senior investigator. A general computer simulation model of a fishery on interacting species is presently being developed, in two major parts: a biological section and an economic section. The biological section will include interactions among the species at several stages of their life histories. The economic section will include capital and operating expenditures of the industry and management agency. Potential profit under various fishery and management policies will be investigated. Particular attention will be placed on the potential benefit of forecasting changes in the density and availability of the populations. Although the model will be general, studies on the fishing and management policies will be based on current knowledge of the population dynamics and fisheries of Pacific sardine, northern anchovy, and Pacific mackerel.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0066, SIMULATION MODELS OF SHALLOW-WATER AND COASTAL ENVIRONMENTS

J.W. HARBAUGH, Stanford University, Graduate School, *Palo Alto - Stanford, California* 94305

4. SURVEY AND PREDICTION

Versatile, general simulation computer programs are being developed to realistically imitate the major natural processes operative in coastal and shallow-water environments. These models are being modified and adapted to simulate selected specific localities such as Florida Bay, Mississippi Delta, and the barrier beaches of southern Texas, to assure their validity.

Environmental information is often inadequate on coastal and nearshore areas in which operations must be performed. One means of filling gaps in the data and of inferring the hydrologic and sedimentary processes responsible for the observable environmental features is through the use of mathematical simulations. A realistically performing model should reveal the magnitude and interrelations of local environmental variables and predict environmental conditions.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0067, MODEL FOR PRELIMINARY EVALUATION OF TOTAL CARGO TRANSPORTATION TIME AND TRANSPORTATION COST FOR ADVANCED CARGO TRANSPORTATION SYSTEMS

J.G. GROSS, U.S. Dept. of Commerce, Maritime Administration, *Washington, District of Columbia* 20235

This computerized transportation analysis model is an approach to the determination of 'total system' costs involved in cargo movement, and 'Total' transportation time involved with this movement. The goal was to explore a method for determining transport cost and time on a comparable system basis, irrespective of the vehicles used in the system: and to have minimum input other than that required for the physical structure of the system.

The program was developed for a preliminary analysis of a broad range of vehicle types - aircraft to displacement ships, and the analysis of comparable transportation costs for each - shipper to consignee. It considers the vehicle is engaged in a hypothetical transportation system consisting of inland rail and truck operations, marine cargo consolidation and packaging, inland and port cargo handling, and prime vehicle line haul movements. The range cost considerations are prime vehicle line haul movements. The range of cost considerations are prime vehicle investment, cargo handling (inland and prime vehicle terminal), cargo characteristics (packaging, specific volume, value), type of handling equipment, packaging, insurance (vehicle and cargo), documentation, cargo claims (inland and port), vehicle operation, wharfage or terminal, vehicle handling, and inland line haul cost. Transportation time factors include the same areas, particularly vehicle port interfacing, vehicle speed variations, inland and terminal delays of cargo, and port cargo storage times.

The model output included one detail system time and cost breakdown and a less detailed output of speed, transport time, specific volume, transport costs for raviations in cargo specific volume. The model is of the deterministic steady state type. It is written in FORTRAN IV for H200. As yet no model operating documentation exists.

Operation to date has been good when analyzing broad category of vehicles on a consistent basis. Such vehicles as hydrofoil, surface effect ships, various displacement ships types, and aircraft have been explored by the model. Estimating relationships and logic are still considered preliminary.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

4.0068, ADVANCED MARINE TRANSPORTATION SYSTEM/ANALYSIS MODEL

J.G. GROSS, U.S. Dept. of Commerce, Maritime Administration, *Washington, District of Columbia* 20235

An overview study and project outline was made to determine the composition of models that could be used effectively to determine long range commodity demands for international transportation, and to analyze advanced marine transportation systems.

A Transportation Requirements Model is needed to provide the ability to identify and analyze major flows of commodity by sources, sinks and time frame. The input to this model will be records and statistics of government agencies charged with compiling information on industry production, raw material requirements, population level, area technology and social development status. The algorithm output will incluce quantity and type of commodity, transportation demand at each source and sink during each time increment, and the transportation quality required.

An Advanced Ship Analysis Model is needed to consider the output of the Transportation Requirements Model, and reject or analyze advanced vehicle concepts as a part of the total system for future time frames. It has the function of providing a means of loading the demand into the optimum transportation network, and listing by ranked order the best choice of mode, next best, etc.

The study considers such factors as transportation market requirements, modal performance, selection of the best mode, transport system characteristics, route structures, level of operation and system constraints. The type of output that would result is total cost of transportation, demand deficiency, operators' financial analysis, vehicle manufacturers' financial analysis, route and vehicle analysis, commodity-route analysis, system summary of mode/vehicle type, system timing for new equipment in production and retirement, and time in transit.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

4.0069, MODEL FOR THE PRELIMINARY EVALUATION OF TOTAL VALUE AND QUANTITY OF IMPORT AND EXPORT FOR WORLD TRADE AREAS

J.G. GROSS, U.S. Dept. of Commerce, Maritime Administration, *Washington, District of Columbia* 20235

This study is an attempt to idealize world trade flow into a mathematical model. The goal is to determine if, for two selected countries, such parameters as GNP, distance between countries, variables for neighboring countries, trade policy preferences, levels of industrialization, and population can be related so that value, tonnage, and transportation characteristics between the two countries can be determined. The rate of change of each variable with time is built into the model, thus giving some capability to forecast cargo flow for future years.

The model has been operated to the extent that measurement of trade value and tonnage between 36 trade nodes were determined in ten increments to the year 2010. A summation of the cargo flow to and from all trade areas to a selected trade area yields the import and export of that trade area.

The model is written in Fortran IV for IBM 7090. As yet, no model operating documentation exists and further analysis is needed to accurately determine model correction and performance.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

4.0070, NUCLEAR FUEL COST ANALYSIS MODEL

P.B. MENTZ, U.S. Dept. of Commerce, Maritime Administration, *Washington, District of Columbia* 20235

A Nuclear Fuel Cost Analysis Model has been developed to analyze fuel costs for potential nuclear merchant ships. The model has been programmed in Fortran IV and is currently being run on a Honeywell 200 computer.

The model will calculate overall fuel costs for nuclear ship propulsion systems on a life-cycle basis. Included within the cost structure are components dealing with uranium inventory, enrichment, conversion, fabrication, refueling, and reprocessing. For convenience, the estimating relationships for each of these key economic parameters may be readily modified in order to assess the effect of a potential change in either technology or pricing.

The operational characteristics of a thermal, pressurized water reactor (PWR) are approximated by the use of a simplified nuclear fuel model, utilizing average values of conversion ratios, cross sections, and leakage probabilities. Output parameters, in addition to specific fuel cost, include initial and final enrichments, uranium inventory and burnup, and fissle plutonium discharge.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

4.0071, ARGONNE MICROMETEOROLOGICAL MODELING FACILITY PROPOSAL

H. MOSES, Argonne National Laboratory, *Argonne - Lemont, Illinois*

Argonne National Laboratory is proposing to the Atomic Energy Commission a program for modeling micrometeorological phenomena, with special emphasis on atmospheric diffusion problems. This program will include basic research into the structure of turbulence and diffusion and applied research into such areas as flow patterns and dilution rates in the vicinity of buildings, reactor complexes, etc. Theoretical analyses and field experiments will be conducted in addition to and supplementing the modeling work. Turbulence and diffusion rates in areas of complex terrain are poorly understood; Safety analysis reports for reactors based on current knowledge are not very reliable and may lead to improper or overdesign of safety features. Modeling air flow in a large wind tunnel, with proper controls of turbulence intensity of vertical temperature and wind speed profiles, will result in more accurate hazard reports.

Results to Date: A feasibility study for the modeling facility has been completed by the Cornell Aeronautics Laboratory, Buffalo, New York. This study included: (1) a conference attended by fluid dynamicists and meteorologists to advise on design criteria for the wind studies including experimental tests on techniques for proper simulation of atmospheric motions, (2) literature and engineering studies including experimental tests on techniques for producing turbulence necessary for modeling atmospheric diffusion, (3) a literature and engineering study on techniques for controlling the temperature field with emphasis on maintaining a preset vertical temperature gradient over a range of turbulence intensities, and (4) development and analysis of tunnel design parameters.

SUPPORTED BY U.S. Atomic Energy Commission

4.0072, COMPETITVE MERCHANT SHIP (BULK) DEVELOPMENTAL PLAN

UNKNOWN, Booz Allen Applied Res. Inc. , *Washington - Bethesda, Maryland*

PURPOSE: To develop a plan for producing advanced nightly productive dry bulk cargo ship systems that best fulfill national requirements, and have multi-application and lowest life cycle costs.

DESCRIPTION: An investigation of the commercial and national requirements for American Flag dry bulk cargo ships and an evaluation of feasible shipping concepts will be made. This will include forecasts of the inbound-out-bound movement of dry bulk commodities and other cargoes which might feasibly be carried in bulk form. Alternative levels of American Flag dry bulk shipping capacity will be studied to determine possible effects on strategic, economic and political national goals. An economic and technical analysis of all feasible shipping concepts will be conducted, along with investigations to determine the most effective financing method to employ, the technical innovations which would ensure lowest life time cost, and the trades in which these ships could compete most effectively. The results will be used as a basis for preparing a Strategic Development Plan that will most effectively produce competitive dry bulk carriers.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

4.0073, THE APPLICATION OF MATHEMATICAL METHODS IN CERTAIN OCEANOGRAPHIC PROBLEMS

G.F. CARRIER, Harvard University, Graduate School, *Cambridge, Massachusetts* 02138

OONO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY John S. Guggenheim Memorial Foundation

4.0074, EFFECTS OF SCALE AND OPERATING TECHNIQUE ON HARBOR MODELS

R.Y. HUDSON, U.S. Army, Waterways Experiment Sta. , *Vicksburg, Mississippi*

The objective of this project is to determine the effects of model scale and the techniques of model operation on the accuracy of model results. Tests will be conducted to establish the bases of model design, operation, and analysis of test results. Studies to be made are wave filters for harbor models and wave flumes, wave attentuation due to bottom friction, and design of ripple tank and appurtenances.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0075, DYNAMIC MODEL STUDY OF LAKE ERIE

R.R. RUMER, State University of New York, School of Engineering, *Buffalo, New York* 14214

A rotating laboratory (11' x 18') is being used for a hydraulic model study of Lake Erie. The principal objective of this study is to determine the degree of usefulness of a rotating vertically distorted Froude model in the prediction of the response of Lake Erie to various physical inputs such as inflows, wind stress, etc. Analytical studies of others as well as of the investigators will be used in attempts to predict the dynamic behavior of the model lake. Field data taken during the GLIRB study and reports of other field studies will be used in the model verification process.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

4.0076, HYDROLOGIC SYSTEMS ANALYSIS OF THE GREAT LAKES

W. BRUTSAERT, Cornell University, School of Engineering, *Ithaca, New York*

The objective of this project is a preliminary study of the Great Lakes as a hydrologic system. In other words an attempt will be made to characterize the basin as a 'black box' from physical as well as from purely mathematical considerations.

The inflow-outflow and storage relationships will be investigated by means of different linear and non-linear models which are presently known in the literature. New runoff-routing models appropriate for the specific conditions of large water bodies - with or without regulated water levels - will be developed and tested.

The usefulness of the available hydrographic and meteorologic data will be assessed; this will in part dictate the direction of future studies.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
Cornell University

4.0077, NUMERICAL OCEANOGRAPHIC MODEL DEVELOPMENT FOR ENVIRONMENTAL PREDICTION

W.J. PIERSON, New York University, School of Engineering, *New York, New York* 10003 (NONR)

Objective: Navy oceanographic forecasting services require improved numerical models of the ocean to support tactical and logistical operations of the fleet. The aim of this research is to develop a numerical model of the ocean and overlying planetary boundary layer of the atmosphere to contribute to the improvement of meteorological forecasts over oceanic areas as well as oceanographic forecasts.

Approach: A finite difference mathematical model of the Atlantic is being developed according to the 'Box Method' used previously by other investigators. A quasi-climatological model for typical monthly conditions will be generated first to develop water mass distributions and currents more realistically than is done presently by available models. Methods for altering the grid system within the model are being devised to account for moving shear zones, meandering currents, and varying depths of the thermocline. A computer program also is being developed to obtain the amount of solar radiation that hits the surface waters of the ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0078, AIR-SEA INTERACTION AND PLANKTON ECOLOGY

E.R. BAYLOR, State University of New York, Graduate School, *Stony Brook, New York* 11790

4. SURVEY AND PREDICTION

The project is to test the predictions of two models that relate the in situ abundance of plankton to the air and the water circulation patterns at the sea surface.

The first of the two models relates small-scale patchiness of plankton abundance to the water circulation patterns described by Langmuir (1938). The second of the two models related larger-scale (one kilometer) patches of plankton abundance to air circulation patterns such as those described by Woodcock and Wyman (1947).

The model that relates Langmuir circulation to small-scale patchiness of plankton predicts that localized increases of plankton abundance are correlated with the temperature perturbations produced by the Langmuir circulation pattern.

The kilometer scale model relates patchiness of plankton to the Wyman-Woodcock horizontal vortex air-circulation pattern and predicts large patches of plankton abundance beneath the parallel lines of clouds that mark the up-welling air from circulation convergences at the sea surface.

The sampling program was designed to ask whether plankton abundance (in situ high frequency sonar counts) was correlated with water temperature perturbations at Langmuir down-welling and whether air temperature and humidity (kite bourne telemetry at cloud base level) were correlated with cloud lines and large scale patchiness of plankton.

SUPPORTED BY U.S. National Science Foundation

4.0079, ESTUARINE SEDIMENTARY MODELS

G.S. VISHER, Univ. of Tulsa, Graduate School, *Tulsa, Oklahoma* 74104

The primary aims are to provide information for a general process- response model for the tidal-estuary-distributary environmental association, and to test the hypothesis that texture may be used directly in the identification of specific sedimentary processes. Work on fluid flow in natural stream channels has demonstrated the association of textures with specific flow regimes. In addition, recent textural studies of clastic sediments suggest the possibility that texture may be used directly in determining ancient sedimentary processes in a more specific manner than previously possible. An observation program to test these hypotheses will be carried out in the estuary of the Altamaha River.

The data will be used to develop a statistical model of the area for comparison to ancient rocks, and to evaluate the effects of differing sedimentary processes on grain size distributions.

SUPPORTED BY U.S. National Science Foundation

4.0080, DELAY LINE COMPUTER

D.D. AUFENKAMP, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

The purpose of this task is to apply modern computer techniques to oceanography on a real time basis. It is anticipated that this will be accomplished by first developing a mathematical model to describe the exchange processes taking place within a given volume of the ocean and then, using moored buoys and other platforms to measure the oceanographic and meteorological parameters, compare the model in a hybrid analog digital computer with the actual measurements correcting the model as necessary to fit the real environment.

The ability to predict acoustic conditions and water motions as they affect vehicle operations and underseas construction depends on a thorough knowledge of the energy exchange processes taking place within the ocean and between the ocean and the atmosphere. This task holds great promise for improving our understanding of these processes.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0081, USE OF ON-LINE COMPUTERS FOR ENVIRONMENTAL RESEARCH

D.D. AUFENKAMP, Oregon State University, Graduate School, *Corvallis, Oregon* 97331 (N00014-68-A-0148)

The purpose of this task is to apply modern computer techniques to oceanography on a real time basis. It is anticipated that this will be accomplished by first developing a mathematical model to describe the exchange processes taking place within a given volume of the ocean and then, using moored buoys and other platforms to measure the oceanographic and meteorological parameters, compare the model in a hybrid analog digital computer with the actual measurements correcting the model as necessary to fit the real environment.

The ability to predict acoustic conditons as they affect Navy systems and water motions as they affect vehicle operations and underseas construction depends on a thorough knowledge of the energy exchange processes taking place within the ocean and between the ocean and the atmosphere. This task holds great promise for improving our understanding of these processes.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0082, COMPUTER SIMULATION OF THE PROPAGATION OF SURFACE WAVES

W.H. ESPEY, Tracor Incorporated, *Austin, Texas* 78721

The propagation of surface waves from deep to shallow water over composite or irregular slopes is an extremely difficult and complex fluid problem. In many cases, semi-empirical approaches have been used to solve practical problems because of the complexity of the basic Navier-Stokes equations which describe the flow field. In deep water these assumptions of irrational flow and small particle motion, which lead to linearized equations, are justified. However as the wave advances toward the shore, the wave form changes and becomes highly unsymmetrical and nonlinear. Because of these effects, a true description of the propagation of surface waves from deep to shallow water over complex bottom geometry must be based on the complete Navier- Stokes equations. The problem approach used in this study is based on a combination of numerical computer simulation techniques to solve the completer Navier-Stokes equations.

The TRACOR Hydrodynamic Model, which solves the two-dimensional Navier-Stokes equation, has been expanded to simulate the propagation of surface waves in the Coastal Engineering Research Center large wave tank. The tank employs a flap-type wave generator. However, due to the rectangular grid representation of the fluid in the model, it is convenient to replace the flap-type wave generator for this study by an equivalent piston type wave generator. Model results are presented in the form of water surface fluctuations at various stations in the large wave tank for later comparison with actual field data collected in the CERC wave tank. Model results in the form of pressure and velocity profiles are also compared with small amplitude wave theory.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0083, NUMERICAL SIMULATION OF HYDRODYNAMIC PHENOMENA BY DIGITAL COMPUTER

C. LAI, U.S. Dept. of Interior, Water Resources Division, *Arlington, Virginia*

Purpose: To develop numerical methods for solving selected surface and ground water fluid dynamics problems; to develop new computer simulation techniques with which to model natural field phenomena.

Methods: Movements of wave-crest in open channels will be simulated, pictorial representations of surface profiles of wave-crest movements will be developed and results will be compared with field observations.

Free-surface, unsteady, gravity flow through porous media induced by transient open-channel flows will be simulated by digital models.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0084, UTILIZATION OF PHYSICAL AND MATHEMATICAL MODELS IN MARINE WATER RESOURCES RESEARCH AND MANAGEMENT

W.J. HARGIS, Virginia Inst. of Marine Sci., *Gloucester, Virginia*

Increased use of hydraulic and mathematical models in research, planning engineering and conserving estuarine and coastal environments is important. The proposed project will utilize VIMS hydraulic model of the tidal James system and analogue, digital and hybrid mathematical modeling capabilities in a program of research designed to evaluate and improve the capabilities of each technique. Thus, the accuracy, precision and capabilities of all likely will be improved, or at least, clarified.

It is expected that improved ability to predict the changes which will result in such biologically, economically, socially and politically important environmental factors as salinity distribution, currents sedimentation, bottom scour and shore erosion will result.

This project is relevant to the projected Chesapeake Bay Hydraulic Model.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
Virginia Institute of Marine Science

4F. NAVIGATION

4.0085, EARTH CURRENT STUDIES

V.P. HESSLER, Univ. of Alaska, Geophysical Institute, *College, Alaska* 99735

At Barrow and College, Alaska, and on drifting ice stations records are made of macro-telluric activity in a study of the relationships between the orientation and motions of auroral forms, as photographed by an All-Sky camera, and variations in the telluric vector in the sea. Geomagnetic micropulsation studies are made with perpendicular induction loops oriented in the H, D and Z coordinates with the primary objective of studying the polarization of both the electric (telluric currents) and the magnetic perburbation vectors. Data are analyzed for characteristic polarization with respect to diurnal variation, storm time and spectrum of the disturbance.

A close relationship exists between ionospheric auroral activity, geomagnetic micropulsations and earth current phenomena. Such relationships are relevant to the evolution and application of communication, navigation and detection systems and are of interest, therefore, to all Navy Bureaus and Laboratories having responsibilities in those areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0086, VISUAL LANDING AIDS FIELD

J.W. SIMEROTH, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Arcata, California*

To study under service conditions the performance of visibility meters, the characteristics of fog, the threshold constants of the human eye, and the performance of airfield lighting systems and components. Related to NBS Mission Component 1.6 Research and Development for another agency.

Reporting Interval February 1967-December 1967.

Four fog detectors/visibility meters developed by commercial firms have been installed at the NBS Arcata Field Laboratory for study. The instruments are 1) a near-infrared back-scatter meter developed by Hoffman Electronics, 2) a forward-scatter meter developed by Thomas A. Edison Industries, 3) a fog detector developed by the AGA Corporation of Sweden, and 4) a modified Frungel side scatter meter. Recordings of the outputs of these instruments are being obtained in a variety of weather conditions. Simultaneous recordings are being made of the outputs of the several transmissometers installed in the test area. Preparation of an airfield lighting maintenance manual has continued. Field tests have been made of various lighting fixtures.

SUPPORTED BY U.S. Dept. of Commerce N.B.S.

4.0087, EVALUATION OF CONTEMPORARY PRECISION NAVIGATION SYSTEMS

K.E. TAYLOR, U.S. Dept. of Interior, Marine Min. Technol. Ctr., *Belvedere - Tiburon, California* 94920

The design, installation, test and evaluation of a RADIST plotter aboard the R/V VIRGINIA CITY, which will be used in conjunction with the RADIST navigating instruments that were procured during FY 1968.

To conduct feasibility studies for adapting the R/V VIRGINIA CITY to utilize the Satellite Navigation System presently scheduled to be operational by January 1970.

The design, installation, test and evaluation of a recording fathometer aboard the R/V VIRGINIA CITY, which will be used in conjunction with the presently installed fathometer.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

4.0088, A STUDY OF PROBLEMS RELATED TO WIND-GENERATED WAVES

R.L. STREET, Stanford University, School of Engineering, *Palo Alto - Stanford, California* 94305

This research will complement theoretical analyses and extend a previous investigation of wind-generated waves. Specific programs to be covered during the course of this research are: 1. Investigations of the characteristics of a turbulent boundary layer over a progressive wavy surface. 2. Investigations of the interactions between the perturbation velocity and natural free-stream (or background) turbulence. 3. Measurements of normal pressures over wind-generated waves.

SUPPORTED BY U.S. National Science Foundation

4.0089, WWV BROADCASTS

R. CARLE, U.S. Dept. of Commerce, Time & Frequency Div., *Boulder, Colorado* 80302

To provide state-of-the-art accuracy High Frequency Time Signals.

Standard frequency and time broadcasts are being provided at six high frequencies, 2.5, 5, 10, 15, 20, and 25 MHz from the station located at Fort Collins, Colorado. These signals are maintained, as broadcast, within within 10 microseconds of the NBS-Boulder master clocks.

These broadcasts are received nearly worldwide and are used extensively as a timing reference in many navigation systems. A navigator can easily determine his position on the earth by utilizing WWV timing signal along with other observations.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0090, WWVB-WWVL BROADCASTS

R.F. CARLE, U.S. Dept. of Commerce, Time & Frequency Div., *Boulder, Colorado* 80302

To provide state-of-the-art accuracy Low Frequency Time Signals and to provide experimental Very Low Frequency Broadcasts. Continental U.S. is served by 60 kHz for precise signals suitable for automatic recording. Experimental 20 kHz signals are being used in quest of a world-wide timing system.

Standard frequency and time broadcasts are being provided at 60 kHz. Experimental low frequency transmissions are being provided at 19.9 and 20.0 kHz. These transmissions presently maintain a frequency accuracy better than 1 part in 10 to the 11th and time information within plus or minus 10 microseconds of NBS-Boulder master clocks.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0091, SATELLITE TIME DISSEMINATION

L.E. GATTERER, U.S. Dept. of Commerce, Time & Frequency Div., *Boulder, Colorado* 80302

The technical objective is to study, both theoretically and experimentally, the feasibility of disseminating time and frequency from an artifical earth satellite.

A literature survey has been conducted to determine what success various experimental satellite timing systems have had to date. Theoretical studies have been made to evaluate various atmospheric effects as a function of radio frequency and a small experimental program has been undertaken to evaluate the possibility of satellite range determination based upon Doppler frequency measurements.

The literature survey is being kept up to date and the theoretical studies are essentially complete and await further experimental data before significant additional progress may be made. Several satellites are being observed at the present time for Doppler data. Simple procedures have been developed for range determinations. Although these methods will not produce results which are attainable by more elaborate, sophisticated methods (which are not suitable for the average user of a timing signal), preliminary results indicate that, under good conditions, range determinations may be made to 100 km which correspond to a timing error of about 300 microseconds compared with 1 ms which is available, under good conditions, from WWV.

Navigation systems used in the oceans and over the oceans (air navigation) are particularly dependent on the accuracy of received time and frequency information.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0092, VLF TIMING STUDIES

G. KAMAS, U.S. Dept. of Commerce, Time & Frequency Div. , *Boulder, Colorado* 80302

The project studies propagation characteristics of VLF signals as they apply to the dissemination of standard time and frequency signals. The main concern is the area of spectrum occupied by NBS station WWVL. The project deals mainly with phase velocity, group velocity, signal attenuation and total path delays.

The approach to the solution of the problem is to measure the phase path delay as a function of direction from the transmitter, frequency and distance. This is accomplished with precision clocks and stable receivers. The group velocity is computed by measuring several frequencies that are closely spaced.

To date, the project has been able to measure the phase velocity at 18.6, 19.9, 20.0, and 20.5 kHz. Directions used have been all except North. The measurements range from 100 to 5000 km from the respective transmitters. In addition to the field measurements, a theoretical model is being generated that will permit time and group delay predictions over continental paths. Also the measurement technique has been developed to a point where it is felt that useful group delay measurements can now be made.

Sea navigation systems are dependent on VLF transmissions which are unaffected by atmospheric disturbances. The received signal has little degradation compared to transmissions at higher frequencies.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0093, IMPROVED STANDARDS FOR RADIO AND ELECTRONIC EQUIPMENT

UNKNOWN, Radio Tech. Comm. Marine Serv. , *Washington, District of Columbia*

PURPOSE: To investigate and recommend improvements in ship communications and electronic navigation.

DESCRIPTION: Cooperative efforts of government agencies and industry are undertaken to investigate ship communications, navigation and safety by special committees that are assigned on a problem and need basis. The technicians and scientists on these committees secure contributory research and investigation inputs on technical, economic, social and political matters within the best competence of their agencies and companies. Forecasts are made of most probable directions, importance, and timing of technical needs for future innovations. Special committees prepare reports on satellite communications, radar criteria, and navigation aids.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

4.0094, MICRONESIAN NAVIGATION AND SAILING

S.H. RIESENBERG, Smithsonian Institution, *Washington, District of Columbia* 20560

This is an ethnographic study of Puluwat, in the central Caroline Islands, focused on Micronesian navigation and sailing. It includes studies of the technological, linguistic, and cognitive aspects of the sailing complex, and an examination of its ramifications through and functional interrelationships with the entire culture of Puluwat.

SUPPORTED BY Smithsonian Institution

4.0095, AUDITORY DETECTION

E.L. CORLISS, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

To determine the optimum spectrum of fog signals for detectability against background of shipboard noise. To develop a description of the spectral and temporal characteristics of fog signals that would optimize their detection above the background of shipboard noise, for the use of the Coast Guard in setting up fog signals.

January 1 to December 31, 1967. Samples of shipboard noise provided by the U. S. Coast Guard have been analyzed by several filtering techniques. Durations of spectral features are such that analysis over tenth-octave bands does not impair observations of the temporal structure, whereas a wave analyzer having less than 3% bandwidth evidently integrates over features in the original signal. Equipment for gating brief signals of controlled character has been set up, for use in simulating fog signals.

Study time-varying spectral distributions of specimen fog signals and shipboard noise and reduce with regard to loudness-weighting behavior of ear. Evaluate, using signal-detection theory as applied to ear, in terms of engineering predictions of audibility. Devise improved spectral distributions and check against jury.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0096, DUPLICATE LIMIT STANDARDS FOR SIGNAL COLORS

K.L. KELLY, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

Traffic control for land, sea, and air transportation depends upon signal-light colors largely produced by plastic or glass filters combined with an incandescent lamp. The permitted range of chromaticities for each of the fifteen colors is specified in terms of the CIE (X,Y)-chromaticity diagram, but the practical control of these chromaticities is by means of eighteen limit standards in the form of two-inch glass squares. The problem is to obtain a supply of duplicate limit standards for issuance to manufacturers of glass and plastic ware, manufacturers of signal lights, and purchasers of such lights.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0097, APPLICATION OF ISCC-NBS CENTROID COLORS AND METHOD OF DESIGNATION COLORS

K.L. KELLY, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

The problem is the application of the ISCC-NBS centroid colors and ISCC-NBS Method of Designating Colors to the solution of problems in the fields of color charts, color codes, color standards, color communication and color designation. This project is closely related to NBS Mission Component 2, Physical Measurement Systems.

Reporting Period: February - December 1967.

The extent to which the application of ISCC-NBS centroid colors has grown and the diversity of the applications can be indicated best by listing a number of them for 1967. These are: colors of plastic- coated fencing; revision of Federal Standard 595 (Paint); IBM color standards and color programs; Science Fair projects; Army Map Service map colors; B. F. Goodrich color book on plastics; colors of HEW flag; colors of envelopes for auto sorting of P.O.; color in thermoplastics; color comparison methods; color and illuminants; representations of color blindness; Things of Science by Science Service; FAA color standards and tolerances; color in the building industry; centroid colors in fashion color communications in Simplicity Fashion Magazine; teaching color (Vienna, Austria); matching centroids in printing inks (Pantone Press); World Book of Knowledge; traffic sign color code; Central America Research Institute for Industry (Gutemala); Manual of American Society of Photogrammetry, Dr. I. M. Yeynmen (Turkey). To disseminate information about this method of designating colors, an NBS Staff lecture and five talks before technical organizations, ISCC Subcommittee on Color in the Building Industry; Color Marketing Bureau of Public Roads; were given on invitation during the year.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0098, DIVER-ASSISTED OCEANOGRAPHY

L.H. BRESLAU, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

OBJECTIVE: The investigators will develop a diver-assisted oceanographic surveying capability for determining the nature of the undersea environment with ultra-high resolution to a depth of 100 fathoms. They will integrate diver manned survey methods with conventional oceanographic methods to produce an optimum blend of techniques for any oceangraphic survey mission. Research efforts will involve conducting diver-assisted oceanographic experiments which will include: (A) Determining the temporal and spatial variability of seafloor and water column features. (B) Directly observing and measuring the effects of the biocoenosis, and correlating their variability with the ocean environment characteristics.

APPROACH: Divers can provide the closest control obtainable on undersea investigation by performing direct observations, and by selectivity operating measurement devices, sampling devices, and photographic equipment. Scientifically trained personnel can make quick evaluations of undersea conditions to design and/or modify experiments on site, tailoring efforts to obtain desired results. Givers will make sea floor traverses to supplement, and test the resolution of conventional survey methods in continental shelf areas. Diving scientific personnel will experiment with and evaluate diver operated vehicles and instruments, in order to develop capabilities for advanced undersea studies. They will develop and test undersea surveying techniques for exact specification of undersea environment by providing methods for: (1) Bottom truth surveys (A) Exact mapping of seafloor topography, sediment types, and bedrock. (B) Characterization of seafloor slope stability, trafficability, and scour resistance. (2) Water column seafloor interaction--make firsthand observations and design instrument arrays and methods of measurement of water column-seafloor interactions including correct-topography relationships, sedimentation rates, and near-bottom current velocity profiles. (3) Detailed study of temperature-density structure and mass movements in the mixed surface layer. The investigators will develop techniques for specifying details of internal wave motion, thermal structure, and layer movements in the highly structural mixed layer.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0099, PRECISE RADIO NAVIGATION FOR SHIPS

F.J. ROMANO, U.S. Navy, Ship Systems Command, *Washington, District of Columbia* 20360

Objective: Develop improved surface references (including buoy, mooring, radar, target, light, and flags) required for navigation by radio frequency sensors, and time-controlled radio frequency positioning equipment.

Approach: The performance of buoyant components will be compared when size and shape are varied and tested. Mooring techniques will be investigated and compared. The value of secondary references on the bottom will be investigated. Improved adjuvants such as lights, flags, and radar reflectors will be developed. Techniques of anchoring will be investigated and small lightweight anchors with improved holding capability will be developed. Components will then be integrated.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0100, SONIC UNDERWATER NAVIGATION FOR SHIPS

F.J. ROMANO, U.S. Navy, Ship Systems Command, *Washington, District of Columbia* 20360

Objective: To develop a means for accurate navigation of ships utilizing acoustic techniques. The equipment should provide for guidance of the ships along a channel. The equipment should be portable and capable of rapid installation, and references should have a life of at least two months. Presently, traffic craft must utilize equipment normally carried on board for ocean navigation, and narrow channels cannot be navigated without pilots and visual references.

Portable shipboard equipment which can be installed on any ship which must traverse the channel will minimize the total equipment cost by allowing the same equipment to be used by more than one ship. Previous studies concluded that, when performance and development time and cost are considered, the acoustic approach ranks significantly higher than radio ranging, radar, visual piloting, leader cable, and visual beam guidance.

SUPPORTED BY U.S. Dept. of Defense - Navy

4. SURVEY AND PREDICTION

4.0101, NAVIGATION SYSTEMS FOR SURVEY APPLICATIONS

W.M. SWARTWOOD, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objective: Provide 24-hour positioning and/or precise navigation capabilities, for survey vehicles under technical control of NAVOCEANO, on a worldwide basis to meet the requirements of hydrographic, oceanographic, bathymetric, and geophysical surveys. Provide precision navigation capabilities for positioning survey craft engaged in coastal operations without the use of land based equipment. Present capabilities for mid-ocean surveys are limited to areas serviced by relatively short ranged electronic positioning systems.

Approach: Testing and evaluation has begun on the VLF/OMEGA/NAVSAT system which should increase navigational control accuracies in the broad ocean areas covered by OMEGA, or VLF ranging.

Development will then be initiated to find an appropriate inertial, or other type sensor, which can be interfaced with the VLF/OMEGA/NAVSAT system to provide continuous control with accuracies on the order of the plus or minus 0.5 miles now possible in good Loran-C areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0102, ORIENTATION CUES AND PATTERNS OF LONG-DISTANCE TRAVEL OF MARINE TURTLES

A.F. CARR, Univ. of Florida, Graduate School, *Gainesville, Florida* 32601 (NONR)

The investigator is conducting research with regard to tracking marine turtles in their extensive migrations in the open ocean in an effort to determine their routes and the environmental cues that guide them to breeding and feeding sites. He is also examining the 'fine scale' homing abilities displayed by hatchlings in reaching the sea from inland nests.

The identification and analysis of biological mechanisms and systems are of considerable importance to the Navy. The implications to Naval operations made clear by increasing information about biological orientation are expanding, not only to include machine concepts, but also systems concepts and will ultimately relate directly to improved systems.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0103, RADAR SCATTERING

K. HASSELMANN, Univ. Hamburg, *Hamburg, Germany*

Approach - Conduct theoretical research in radar scatter by ocean waves at radar wavelengths comparable to ocean wavelengths, and at radar wavelengths small compared to ocean wavelengths. Calculations will be made by back-scattered energy as a function of wave spectrum, radiation pattern, and position of the source.

Objective - The goal of this work is to guide development work in radar scattermeters for open ocean wave work, either from ships, aircraft or satellites.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0104, BARBERS POINT HARBOR MODEL STUDY

H.P. HARRENSTEIN, Univ. of Hawaii, School of Engineering, *Honolulu, Hawaii* 96822

This was a hydraulic model testing project. The purpose was to aid in the selection of the most suitable plan for design of a deep draft harbor at Barbers Point, Oahu. This project is being continued beyond June 30, 1968, but is expected to be completed by the end of the calendar year. A number of plans have been used, and a great number of tests performed. The selection of the final plan and additional tests were made after June 30, 1968.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0105, VHF SATELLITE COMMUNICATIONS

UNKNOWN, Westinghouse Electric Corp. , *Baltimore - Elkridge, Maryland*

Purpose: To evaluate the future potential of satellite relays for marine communications, ranging and ship control, using experimental data obtained from ship to shore tests.

4. SURVEY AND PREDICTION

Description: Experiments are being conducted with the NASA ATS- 1 and ATS-3 Synchronous Satellites. A shipboard satellite terminal has been installed aboard the Grace Line ship SS SANTA LUCIA and two test voyages have been completed. During these voyages, tests were conducted at a number of points along the ship's route from Newark, N.J., to Valparaiso, Chile, and return. Communications and tests are made between the ship and the three NASA ATS ground stations located at Rosman, North Carolina; Mojave, California; and Cooby Creek, Australia.

Particular emphasis is being given to certain areas pertinent to shipboard application: (1) propagation characteristics and signal yield; (2) transmission and reception of voice communications; (3) feasibility of obtaining accurate position fixes using the satellite ranging technique; (4) accurate time synchronization using time code signals; and (5) transmission and reception of teletype messages.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

4.0106, VLF/OMEGA NAVIGATION
J.J. STANBROUGH, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

The purpose of this study is to (1) provide high precision relative navigation for on station drift measurements, ship speed and course made, doppler corrections for the satellite navigator, and (2) assess Omega/VLF navigation for oceanographic vessels.

This study will contribute to the solution of problems in precise determination of position at sea and to precise navigation.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0107, MARINE GRAVITY
J.L. WORZEL, Columbia University, Graduate School, *Palisades, New York* 10964

The objective of this research is to investigate deflections of the vertical in areas of interest to the Navy. Use will be made of satellite gravity data and shipboard gravity and topographic data. Deflections of the vertical computed from these data will be thoroughly evaluated in terms of the data accuracy and distribution which are required to adequately map deflections of the vertical at sea.

The accuracy of inertial guidance systems which are used extensively by the Navy in ships and airplanes is presently limited by insufficient knowledge about the earth's gravity field and deflections of the vertical. In support of the Navy's efforts to remove this limitation, this program is (1) providing gravity data of increased accuracy over the world's ocean; and (2) developing and evaluating both the computational techniques and the data requirements for determining deflections of the vertical at sea.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0108, SENSORY BASIS OF NAVIGATION IN HOMING PIGEONS
C. WALCOTT, State University of New York, Graduate School, *Stony Brook, New York* 11790

The purpose of this project is to find out what sensory modalities are employed by some birds in responding to environmental cues. The Principal Investigator will continue his research on the orientational- navigational abilities of homing pigeons utilizing radio-telemetric devices. Flight pattern analyses are being made and air-borne tracking methods employed to find the basis for the homing phenomenon.

The ability of animals to navigate accurately over long distances without clues obvious to man is a phenomenon of particular interest to the Navy. Either the mechanism by which the bird navigates can provide information applicable to improved navigation and guidance equipment, or a discovery of environmental directional clues can suggest new concepts of navigation. Such studies may also bring to light human sensory abilities which are not being used.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0109, DISTANT GOAL ORIENTATION
L.C. GRAUE, Bowling Green State University, Graduate School, *Bowling Green, Ohio* 43402 (NONR)

The investigator is studying distant goal orientation in homing birds in an attempt to discover the internal and/or environmental conditions which influence their movements. Magnetic conditions, expecially irregularities, are analyzed in relation to both long and short distance homing phenomenon. Electronic tracking devices have been used to determine the route of the homeward path under experimental conditions. In the final segment of this project, the navigation ability of the animals, when displaced across an ocean, will be studied.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0110, INTEGRATION OF DOPPLER SATELLITE AND LORAC NAVIGATIONAL SERVICES
E.H. MAHONEY, Seismograph Service Corp. , *Tulsa, Oklahoma*

00NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Seismograph Service Corporation

4.0111, ERROR ANALYSIS OF SEVERAL BOTTOM REFERENCED NAVIGATION SYSTEMS FOR SMALL SUBMERSIBLES
G. FAIN, Raytheon Company, *Portsmouth, Rhode Island*

As more and more work is being performed by small submersibles, a definite need has been experienced for an inexpensive and easily implemented local navigation system referenced to the ocean bottom. Such systems are required for search and survey operations and for return to site applications. Many such operations are at present performed by voice command to the submersible pilot from the surface support vessel which tracks the submersible with a directional hydrophone. Allowing the pilot to perform his own navigation with respect to the bottom will result in more efficient operations.

All the bottom referenced navigation systems proposed require the placement of one or more acoustic sources on the ocean bottom with respect to which range and perhaps bearing are determined. These sources may be either transponders or synchronous beacons. The proposed systems usually take either the form of a long base line, short base line or range bearing system.

These three systems have been analyzed in terms of their accuracy and precision considering both systematic and random errors. As accurate submersible navigation is usually important only near the bottom this analysis is limited to near bottom operations. Accuracy and precision in terms of radial and tangential errors are predicted for each system. It is shown that error is a function of bearing angle for the long and short base line system, that ships' roll and pitch increase the error for both the short base line and range-bearing systems, and that the long base line system is the most accurate.

SUPPORTED BY Raytheon Company

4.0112, NAVIGATION RECEIVER
D.M. CRISAFULLI, Amer. Machine & Foundry Co. , *Alexandria, Virginia*

With the present hyperbolic navigation systems such as Loran, etc., accuracy in the order of one half to one mile are about the best obtainable in deep water areas. These accuracies are totally inadequate for most survey, search and exploratory operations. An acoustic transponder system is one way of achieving precise navigation in a local area. The normal technique is to deploy three transponders on the ocean bottom, survey them in, and then, using the slant range of each of these transponders the position of the ship can be determined relative to the transponder array. We presently have in our oceanographic equipment line of products the shipboard interrogation gear and the transponders. In order to have a complete range determining system, we have designed the three channel shipboard navigation receiver. This receiver works in conjunction with our present shipboard interrogation gear and provides the slant range from each of the three transponders directly in the form of a digital display. This range information can then be fed into a computer for computation or the computations can be made manually.

A prototype has been built and manufacturing drawings are completed. The first production model will be built before the end of the year.

SUPPORTED BY Amer. Machine & Foundry Company

4G. SURVEYS-CRUISES

4.0113, 146 D EASTROPAC

C.M. LOVE, U.S. Dept. of Interior, Fishery Oceanography Ctr., *La Jolla, California*

This project has been designed to obtain oceanographic and fish distribution data from the eastern tropical Pacific and represents the Bureau of Commercial Fisheries contribution to a multiagency, international oceanographic survey and monitoring operation. The Bureau objectives are (1) to evaluate the potential of the oceanic tuna stocks; (2) to locate potentially rich areas of aggregation of these fish; and (3) to add to the basic knowledge of the oceanographic climate of the eastern tropical Pacific, particularly to assist in the understanding of seasonal changes. It is the latter phase of work whose results will be immediately applicable in forecasting the movements of tropical tuna on the present fishing grounds which lie generally to the east and inshore of the EASTROPAC area.

Collection of data at sea (the first phase of EASTROPAC) has been completed; the reporting phase, in which the material will be processed and analyzed, is just now beginning. Data will be summarized in three ways: (1) as published charts of vertical sections and horizontal plots of parameters to be used directly in the production of an atlas- type presentation; (2) as tabulated digital data which will form the basis of special studies of biological phenomena and of papers published by individual researchers; and (3) as digital data recorded in computer- compatible form, mostly from physico-chemical measurements, to be used for computer calculation of dynamic equations and for individually published studies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0114, CALIFORNIA CURRENT SURVEYS

P.E. SMITH, U.S. Dept. of Interior, Fishery Oceanography Ctr., *La Jolla, California*

Sea surveys have been conducted off the California coast from 1939-41 on a limited scale, extensively on a monthly basis, off California and Baja California, from 1949-60, and on a quarterly basis from 1961-65. The CalCOFI surveys were resumed in 1968 with two cruises and in 1969 it is planned to carry out a full-scale monthly survey, in cooperation with the University of California, Scripps Institution of Oceanography and the California Department of Fish and Game, of the entire area between San Francisco Bay and lower Baja California.

Data collections include oblique plankton tows, deepened to 200 meters, and hydrographic casts to 600 meters. Physical and chemical oceanographic observations are made at all stations. The processed data will include 1) determinations of depth fished, volume of water strained, etc. for each haul, 2) measurements and standardization of plankton volumes, 3) separation of all fish eggs and larvae from plankton samples, 4) identification and enumeration of fish eggs and larvae and standardization of data.

Information is provided for 1) distribution and numbers of the eggs and larvae of commercial valuable fishes and their ecological associates, 2) physical and chemical environment, 3) plankton volumes related to area, season, and year, 4) plankton constituents which serve as food for most pelagic fish at all stages of development, 5) plankton predators and competitors on eggs and larvae.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0115, SUPPORT OF RESEARCH VESSEL VELERO 4

J. SAVAGE, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

The research vassel VELERO IV, 110-foot ship of tuna clipper design, owned and operated by the Allen Hancock Foundation of the University of Southern California, has served as the major marine facility in a productive research and training program in marine biology and geology since 1948. This ship contains extensive oceanographic and sampling gear, and has an endurance capability of from 30 to 40 days.

SUPPORTED BY U.S. National Science Foundation

4.0116, DESCRIPTIVE OCEANOGRAPHY

W.S. WOOSTER, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The objective is to undertake a detailed investigation and interpretation of the boundary current areas in the eastern Pacific Ocean. During the coming year, the effort will continue to be an integral part of the systematic EASTROPAC investigation aimed at obtaining an understanding of the temporal variations in the circulation of the Eastern Tropical Pacific and of the large-scale air-sea interactions associated with the El Nino phenomenon. During this period, emphasis will be upon the processing and analysis of data collected during the 13 month, multiple cruise EASTROPAC investigation.

This work is of a reconnaissance nature. A considerable amount of such work is needed in relatively little known waters, in waters where there are steep gradients or in waters which change rapidly with time (as off Peru). Such work must be undertaken before other studies can be planned to investigate specific phenomena. Only when there is an adequate description of the overall distribution of properties of an area as well as the annual trend of conditions can meaningful observations be obtained.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0117, SEA SURVEY INVESTIGATIONS

J.L. BAXTER, State Dept. of Fish & Game, *Terminal Island, California*

Objectives: To conduct research vessel surveys designed to assess the distribution, abundance and other vital statistics of the fish populations comprising the fishery resources of the California Current System.

Procedure: Conduct 10, 20-day sea survey cruises; eight echo - sounder and two combination intensive sampling - gear research cruises aboard the Research Vessel ALASKA. Data resulting from these cruises will be compiled and published in the form of data reports.

Location: Cruises will be conducted in coastal waters of California and Baja California, Mexico. Therminal Island for laboratory work and analysis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
California State Government

4.0118, SCIENCE AND ENGINEERING GOALS FOR THE INTERNATIONAL DECADE OF OCEAN EXPLORATION

S.R. KEIM, Natl. Academy of Sciences, *Washington, District of Columbia*

The National Academy of Sciences and the National Academy of Engineering will jointly undertake to provide advice to the National Council on Marine Resources and Engineering Development on the scientific and engineering aspects of the U. S. participation in an International Decade of Ocean Exploration during the 1970's.

As an initial step, the Academies will conduct this contract study which will identify scientific and engineering goals, objectives, milestones, priorities, and timing. Included will be the identification of capabilities required to achieve the goals in terms of manpower, marine data, instrumentation, sea and shore facilities, and funds. The study will also identify end products which should result from the Decade such as charts, maps, research projects, and atlases. Benefits in terms of advances in science and engineering and in the Nation's increased capabilities to use the seas more effectively will be considered.

SUPPORTED BY Natl. Council on Marine Res. & Engin. Dev.

4. SURVEY AND PREDICTION

4.0119, EAST COAST CONTINENTAL MARGIN WOODS HOLE OCEANOGRAPHIC INSTITUTE CONTRACT

J.G. VEDDER, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

Reconnaissance study of the Atlantic Shelf is essentially complete; more detailed study of the geology of the Gulf of Maine at intermediate scale is now underway, as well as study of geochemistry of interstitial waters in marine sediments, and of hydrologic processes operating in marine and estuarine areas.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0120, EASTERN TROPICAL ATLANTIC COOPERATIVE SURVEY 12 SEPTEMBER TO 20 DECEMBER 1968

R.B. ELDER, U.S. Dept. of Transportation, Oceanographic Unit, *Washington, District of Columbia*

The U. S. Coast Guard and the Bureau of Commercial Fisheries are cooperating in a study of the Eastern Tropical Atlantic. Following are the objectives of the program: a. To investigate the distribution of surface schooling tunas in relation to oceanic physical, chemical, and biological parameters, and to sample such schools whenever possible to provide specimens for biological studies. b. To locate and investigate an oceanic front which is found about 1 degree - 3 degrees S. during June-August and apparently moves to about 15 degrees - 16 degrees. by the first of October. c. To study the region of the Angola Dome; a region having abnormally low temperatures in the near surface layers.

The Coast Guard Cutter ROCKAWAY and the Bureau of Commercial Fisheries research ship UNDAUNTED will conduct multi-disciplinary oceanographic investigation in the area. The physical oceanographic data will be published in the CG 373 series publications. Other data will be published by the Bureau of Commercial Fisheries.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0121, INTERNATIONAL WEDDELL SEA OCEANOGRAPHIC EXPEDITION

R.B. ELDER, U.S. Dept. of Transportation, Oceanographic Unit, *Washington, District of Columbia*

On January 3 1969 the USCGC GLACIER (WAGB 4), CAPT Eugene E. McCRORY, Commanding, will depart Punta Arenas, Chile to commence a two phase multi-disciplinary oceanographic survey of the Weddell Sea. Although primarily an icebreaker, the CGC GLACIER has been extensively modified for oceanographic research.

This will be CGX GLACIER's second oceanographic investigation of the Weddell Sea. This research, to be conducted in the austral summer of 1968-1969, will be a logical extension of that already completed during the previous austral summer. The duration of the survey will be approximately three months. The research will be conducted in cooperation with the Argentine Icebreaker, San Martin.

The overall program is being coordinated by the Office of Antartic Programs, National Science Foundation. The program will include the recovery of current buoys installed during IWSOE-1968, hydrograph, nutrient determination, primary productivity, chlorophyll analyses, bottom photographs, benthic biology, seal dynamic population studies and pestor coring.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0122, EASTERN TROPICAL PACIFIC COOPERATIVE SURVEY

R.B. ELDER, U.S. Dept. of Transportation, Oceanographic Unit, *Washington, District of Columbia*

EASTROPAC is a cooperative project by several groups to study the Eastern Tropical Pacific Ocean. The goals of this effort are to increase the harvest of fisheries in this region, to improve weather forcasting, and to improve shipping and navigation in the study area which ranges 20 degrees north and south of the equator. As far as the collection of data is concerned EASTROPAC is complete for the Coast Guard. Processing of the tremendous amount of information that has been gathered is not complete however. The primary interest of the past one and one-half years of EASTROPAC has been physical, chemical and biological oceanography. In these efforts the Oceanographic Unit and CGC ROCKAWAY have been working in cooperation with various U.S. Institutions and those of other countries.

CGC ROCKAWAY participated in three surveys of the project area. In the course of her work CGC ROCKAWAY took a total of 1488 stations in which Nansen, STD, and expendable BT (XBT) casts were made. There were 383, 534, 571 stations respectively for the three cruises.

When all the data has been compiled by EASTROPAC Headquarters a complete oceanographic atlas will be published. Also, the Oceanographic Unit will publish their findings in their Oceanographic Report, CG-373 Series.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0123, OCEANOGRAPHIC STUDY OF NORTHEASTERN U. S. COASTAL WATERS FOR INTERNATIONAL COMMISSION FOR NORTHWEST ATLANTIC FISHERIES

M. LIGHT, U.S. Dept. of Transportation, Oceanographic Unit, *Washington, District of Columbia*

This study consists of a series of oceanographic surveys conducted by CGC EVERGREEN (WAGO 295) in support of a research program planned by the International Commission for Northwest Atlantic Fisheries. The Bureau of Commercial Fisheries Biological Laboratory, Woods Hole, coordinates U. S. participation. This cooperative undertaking involves a study of the offshore fishery resources which are fished by the U. S. and other member nations. The aim of the international program is to seek an understanding of natural fluctuations in abundance of commercial fishes in the area and to assess the effect of fishing. The surveys are conducted 2 or 3 times a year in the coastal slope waters between Cape Cod and Nova Scotia, and the hydrographic data collected supplement data previously collected in the same area during a series of quarterly environmental survey cruises by BCF R/V ALBATROSS III. The purpose of these surveys is to determine the vertical and horizontal distribution of temperature, salinity, dissolved oxygen in these waters which support an intensive commercial fishery. These environmental factors are considered to have important effects on the distribution of pelagic and demersal species of fish and invertebrates.

Data from these cruises are available at the National Oceanographic Data Center approximately two months following each cruise. Complete reports on cruise data will be published by CG Oceanographic Unit in collaboration with the BCF in the Oceanographic Report series (CG 373).

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0124, OCEANOGRAPHY OF THE GRAND BANKS AND LABRADOR SEA

M.J. MOYNIHAN, U.S. Dept. of Transportation, Oceanographic Unit, *Washington, District of Columbia*

The oceanographic program of the Grand Banks and Labrador Sea area is in direct support of the International Ice Patrol mission of the U. S. Coast Guard. The USCGC EVERGREEN (WAGO 295) makes several cruises annually during the ice season (normally February to July) to conduct a comprehensive current survey of the region. The data is processed by computer at sea and transmitted to the Commander, International Ice Patrol in New York for the forecasting of iceberg drift. Deep-moored oceanographic buoys for the collection of hydrographic and weather data have been used and are under further development.

Post Season cruises are made into the Labrador Sea region to study the characteristic circulation of the entire iceberg producing environment, particularly with regards to the sources and variations of the Labrador Current.

Data from these cruises are available at the National Oceanographic Data Center approximately two months following the cruises. These data with analyses are published by the U. S. Coast Guard in the Oceanographic Report Series (CG-373).

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0125, ARCTIC EAST OCEANOGRAPHIC PROJECT (OCEANOGRAPHY OF THE BAFFIN BAY REGION)

M.J. MOYNIHAN, U.S. Dept. of Transportation, Oceanographic Unit, *Washington, District of Columbia*

The U. S. Coast Guard by virtue of its operation of all the icebreakers under the U. S. flag has a definite responsibility for the support and coordination of polar research. The oceanographic program in the Baffin Bay region has its emphasis on the description of the physical, chemical and biological features of Baffin Bay and water exchange through Narres Straits, Jones Sound, Lancaster Sound, and the Davis Strait. This work is designed to support and augment the research of the National Science Foundation, U. S. Navy and other groups working through the Arctic Institute of North America.

Observations from U. S. Coast Guard icebreakers are limited to special selected and scheduled projects and to other available times when these vessels are not engaged in their primary mission of the support of shorebased defense and scientific installation.

Data from these cruises are available at the National Oceanographic Data Center. The scientific results, with contributions from invited scientists, are published by the U. S. Coast Guard in the Oceanographic Report Series (CG-373).

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0126, ATLANTIC OCEANIC BIOLOGY

C.R. STEPHAN, Florida Atlantic University, School of Engineering, *Boca Raton, Florida* (NONR)

The investigator is now integrating the results from the successful Research Ships of Opportunity cruise across the Atlantic Ocean with an evaluation of associated data received from Numerical Weather Facility, Monterey, California, and General Motors Research Laboratory that can lead to a system for rapid transmission of data from RSO's to oceanographic data centers. During the extension period, improved design studies for RSO Instrumentation Modules will be concluded.

The Research Ships of Opportunity concept serves as an implement to hydrobiological research by providing platforms for a broad coverage of the open ocean area, an area hitherte sampled only sporadically. The Navy's need to know about the characteristics of the surface waters might be served more expeditiously by this means. Such properties as water viscosity, color, and plankton density are especially important.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0127, DESCRIPTIVE PHYSICAL OCEANOGRAPHY OF THE EASTERN TROPICAL ATLANTIC

M.C. INGHAM, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab., *Miami, Florida*

Objectives: 1. To describe the oceanic circulation and the distribution of environmental variables in space and time in regions of interest in the eastern tropical Atlantic Ocean. 2. To locate and describe oceanic features in the physical and chemical environment which are significant to primary and secondary production and to the distribution of commercially significant pelagic fishes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0128, THE EVALUATION AND USE OF SUBMERGED RESEARCH VESSELS IN STUDYING CONTINENTAL SHELF ENVIRONMENTS

H.G. GOODELL, Florida State University, Graduate School, *Tallahassee, Florida* 32306

Two submarines have been constructed by Lutjens; one of which is completed and is under evaluation as a one-man reconnaissance vehicle, the other a five-to six-man diver lockout vessel which will hopefully be completed by June 1969, and it too will undergo evaluation as a research and reconnaissance vehicle.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

4.0129, PILOT STUDY OF LIMITED PORTION OF TRADE WIND ZONE OCEANOGRAPHY (DATA AND DESCRIPTIVE REPORTS)

G.R. SECKEL, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Honolulu, Hawaii* 96812

The Trade Wind Zone Oceanography investigation deals with the mechanisms which change the distribution of properties and water masses in the area bounded by latitudes 10 degrees N., 30 degrees N., and longitudes 130 degrees W. and 180 degrees.

A pilot study to test the feasibility of the investigation is in progress and sampling and processing techniques using a single ship are to be developed. Results of this development are presented in data and descriptive reports.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0130, INTERNATIONAL INDIAN CEAN EXPEDITION PHYSICAL AND CHEMICAL ATLAS

K. WYRTKI, Univ. of Hawaii, Graduate School, *Honolulu, Hawaii* 96822

When the International Indian Ocean Expedition was originally planned, it was proposed that atlases containing the distribution of all data accumulated during the Expedition would be prepared. This grant will support the production of the oceanographic atlas which will be in two parts and amenable to research use. Part I will contain the distribution of physical and chemical properties at selected levels and along specific sections of the ocean. Part II will consist of an analysis of all data submitted to World Data Center A, including property distribution, core layer analysis, oxygen, minima and maxima, phosphates, bottom temperature, depth of the mixed layer and intensity of thermocline.

SUPPORTED BY U.S. National Science Foundation

4.0131, DEEP OCEAN RESEARCH AND DEEP OCEAN ENGINEERING

S.C. DAUBIN, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (NONR)

Objective: This research is part of the long range program to utilize the deep ocean. It is based on the use of a system centered about the Deep Research vehicle Alvin. This submersible will take scientists into the ocean to depths of 7500 ft. for observation and sample collection. The studies are divided among geology, biology, geophysics, and engineering. The results will contribute to the ability to use the deep ocean and the sea floor in support of the National Purpose.

Approach: The Deep Research Vehicle Group at Woods Hole will operate the system composed of ALVIN and LULU to make scientific observations to depths of 6500 ft. The biologic studies will encompass life forms and benthic animals that will affect sea floor structures. Additional work on a coherent long range investigation of the geological structure of the continental margin and geophysical studies of slope stability and sediment composition and stability will be undertaken. The moorings of a deep buoy will be examined. Revisits to sites will provide long term observations and tests in the various disciplines of ocean science and ocean engineering.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0132, MEDITERRANEAN OCEANOGRAPHY

A.R. MILLER, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

The purpose of this task is to permit Woods Hole research scientists to participate in a survey in the Eastern Mediterranean aboard the Federal Republic of Germany research vessel PLANET. The primary task will be to determine advective oceanographic processes taking place in the area. Secondarily, observations from cloud camera, pyroheliometer, net radiometer, infra-red and surface microstructure measurements will be taken. Reduction, analysis and interpretation of the data will be accomplished as a part of the task.

SUPPORTED BY U.S. Dept. of Defense - Navy

4. SURVEY AND PREDICTION

4.0133, ANTARCTIC PHYSICAL OCEANOGRAPHY

A.L. GORDON, Columbia University, Graduate School, *Palisades, New York* 10964

Lamont Geological Observatory of Columbia University proposes to collect data on physical and geological oceanography of the southern Pacific and southern Indian Oceans during the period from approximately December 30, 1967, to August 31, 1968. These data would be taken at hydrographic stations from on board the Antarctic Research Vessel USNS Eltanin. They would include the salinity and temperature of the sea water at known depths, between the surface and the bottom, using both bathythermographs and a salinity-temperature-depth continuous recorder. An expendable bathythermographic system would, also, be used to yield continuous temperature measurements to 700 meters while the ship is under way. A structural framework would lower to the bottom at selected stations. It would incorporate equipment to produce oriented bottom photographs, make measurements of bottom currents, and take readings on the light-scattering characteristics of the near-bottom water. Lamont Geological Observatory would process and analyze these data for distribution to other interested scientists and institutions and for deposit in the National Oceanography Data Center. This research is a continuation of LGO work on the Eltanin Cruises 4 to 27.

Five technicians would be on the Eltanin for each cruise during the period of the grant.

SUPPORTED BY U.S. National Science Foundation

4.0134, WATER MASSES, CURRENTS AND ORIGIN OF THE ATLANTIC BOTTOM WATER IN THE WEDDEL SEA, ANTARCTICA

L.R. CAPURRO, Texas A & M University System, Graduate School, *College Station, Texas* 77843

Research will be continued by Texas A & M on the physical oceanography of the Weddell Sea, Antarctica, in the summer of 1968-69, as part of the International Weddell Sea Oceanographic Expedition- 1969. The research will be carried out on the Argentine icebreaker, General San Martin, and at Argentine Antarctic research stations. Hydrographic casts will be made at each ship station for water samples and temperature. In addition, continuous salinity, temperature, and depth measurements, in the upper part of the water column, will be made with and STD instrument. The water samples will be analyzed for salinity, pH, and nutrients. Current measurements will be repeated at the Argentine station, General Belgrano, for about seven days in 1000 meters of water.

Capurro will join the General San Martin, in Agrentine, with two research scientists from the United States and two marine technicians from Argentina. They will stay with the ship throughout the expedition, until it returns to Argentina. Capurro and the other two research scientists will then return to the United States.

SUPPORTED BY U.S. National Science Foundation

4.0135, OCEANOGRAPHIC SURVEY OF CONTINENTAL SHELF WATERS OFF CHESAPEAKE BAY

J.J. NORCROSS, Virginia Inst. of Marine Sci. , *Gloucester Point, Virginia* 23062

Purpose: To acquire a body of data sufficient to describe in general terms the physical processes which occur in Continental Shelf waters.

The Institute has been actively engaged in surveys of Continental Shelf waters since December, 1959. The first surveys were directed toward determination of the distribution of eggs and larvae of fish. Oceanographic data were collected during the three years of the biological survey and the present program is an outgrowth of the initial surveys.

We occupy a total of 36 stations located on four transects. The east west transects are positioned on parallels 37 degrees 10'N, 37 degrees 00'N, 36 degrees 50'N and 36 degrees 40'N. Nansen bottles and bathythermographs are used to obtain measurements of temperature and salinity distributions.

We are working toward development of computer programs which will plot isopleths from the data collected during the cruises.

This is a continuing program.

SUPPORTED BY Virginia State Government

4H. REMOTE SENSING-SPACE OCEANOGRAPHY

4.0136, ENVIRONMENTAL APPLICATIONS OF PASSIVE MICROWAVE SENSORS

A.T. EDGERTON, Aerojet General Corporation, *El Monte, California* 91734 (NONR-4767(00))

Research is being conducted into the applications of passive microwave radiometers to the remote sensing of earth surface and near- surface environments. Laboratory and field studies are relating the microwave brightness temperatures of many environments, including snow and ice, sea ice, soils and sediments, and beach and near-shore localities to a variety of frequencies and observation conditions.

By evaluating the effectiveness of this type of terrain sensor, progress is being made toward exploitation of the high potential of passive microwave radiometers to operate in day/night, all weather conditions, to detect anomalous materials below the earth's surface, and to discriminate between materials of differing dielectric constants such as ice, water, or soil.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0137, APPLICATION OF METEOROLOGICAL SATELLITE SENSING TO GENERAL CIRCULATION MODELS

Y. MINTZ, Univ. of California, Graduate School, *Los Angeles - U.C.L.A. , California* 90024

Objective: To determine which of the sensing devices presently used on Minbus and ATS and proposed for future spacecraft will give the best numerical weather prediction when used to determine the initial conditions, and the utility of non-synoptic data in the numerical prediction procedures.

Approach: A program of testing various types of input data from hypothetical satellite instrumentation in large computer runs of numerical atmospheric models will be carried out. This will include the preparation of a numerical weather prediction procedure and program for experiments with non-synchronous wind and temperature data from such sources as the horizontal sounding balloon systems of the FR-2 (Eole) and Nimbus IRLS Experiments and the Nimbus Infrared Interferometer Spectrometer (IRIS) inferences of vertical temperature profiles in the atmosphere. Simulation runs will be made on a computer prior to the actual satellite launches, and real data from FR-2 and other meteorological systems will be used in the future.

During this period, the Mintz-Arakawa numerical model for simulating atmospheric experiments was revised to include more complicated processes and, thus, more closely reflect the behavior of the true atmosphere. Of the many revisions, two are especially notable: (1) the evaporation of water from the oceans and the condensation of water vapor in the atmosphere have for the first time been treated explicitly, thereby improving the simulation of these important thermodynamical effects and (2) the horizontal grid spacing of the two level model has been reduced from 1 degree latitude to 9 degrees longitude to 4 degrees latitude x 5 degrees longitude, thus improving the model's ability to represent smaller scale atmospheric disturbances.

The new model was used to investigate the dispersion of constant level balloons in a simulated satellite-balloon horizontal sounding system. The results show that the unrealistically strong Hadley cells which swept the balloons out of the tropics in the former model no longer predominate, resulting in a more nearly random distribution of balloons everywhere for a period of the order of one month. These investigations are encouraging in the development of such systems as the Nimbus IRLS and International FR-2 satellite -balloon experiments.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0138, CLOUD PATTERNS RELATED TO SELECTED CIRCULATION SYSTEMS IN EASTERN PACIFIC

S.M. SEREBRENY, Stanford Research Institute, *Menlo Park, California*

Technical Objective. Certain characteristic cloud patterns seen in satellite photographs tend to accompany circulation patterns such as frontal systems, pressure systems vorticity centers and jet streams. Project objective is to establish relationships between cloud patterns and selected circulation systems and synoptic situations over the eastern Pacific and western United States, to obtain increased competence in photo-interpretation for use in weather analysis.

Approach. Satellite cloud photographs used in this study cover the area defined by 15 degrees N-40 degrees N and 95 degrees W-145 degrees W, but conventional analyses relating to these photographs will extend well outside these limits. Results under this extension will be based on 10 cases (days). Analyses and data reductions, using the surface, 500mb, 300mb, 200mb charts and 1000-500mb thickness charts, will be based on all available data, including pilot reports, satellite data, radarscope photographs and upper air soundings. The very heavy rainstorn of January 20-21, 1967 over southern California, and the persistent pronounced thunderstorm activity over the western states in June 1967 form the subject of most of this study. Distinctive cloud patterns in the satellite photographs will be systematically examined and related to the corresponding weather data from conventional sources. Ten selected case studied will be prepared under this contract.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

4.0139, HYDROLOGIC OPTICS - SPACELIGHT SPECTROSCOPY

J.E. TYLER, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

It is proposed, by means of spectroradiometric measurements of the space light generated by multiple scattering of natural light underwater, to determine the spectral composition, absolute magnitude and band width of the radiant flux available for photosynthesis underwater; to measure spectral values of vector and scalar irradiance underwater; to determine spectral values of the distribution factor, the reflection factor, and the absorption coefficient for ocean water; to determine spectral values of the diffuse attenuation coefficient; and to employ these data for the purpose of describing and comparing water masses, studying the interrelation between radiant energy and biological activity underwater, the monochromatic contrast between contiguous water masses and the effect of surface reflections on this contrast.

SUPPORTED BY U.S. National Science Foundation

4.0140, DETECTION AND CLASSIFICATION OF FISH AND MINERAL OIL SLICKS BY REMOTE SENSING FROM ORBITAL ALTITUDE

A.R. BARRINGER, Barringer Research Limited, *Rexdale - Ontario, Canada*

Oil slicks are caused by schools of fish, pollution and undersea oil deposits. For ocean resource evaluation and pollution control purposes, it is desirable to classify oil slicks.

The study was confined to the ultraviolet region of the spectrum because of the interesting ultraviolet absorption properties of the fish and mineral oils. We measured the ability of optical instruments to detect and differentiate different types of oil films. The polarization reflection effects were computed of the air-oil-water interface with the effects of absorption in the oil taken into account. The effects of the sea's surface was investigated in order to determine what angular effects were caused by the waves with respect to the polarization effects and the reflection qualities.

The results of the study show that the fish oils can be readily classified by a multi-band photometric system based on the absorption spectra when the oil sample is viewed in transmission. In reflection the oils are not readily detected or classified in the ultraviolet region of the spectrum. Fish oil slicks are not always discernible in the visible region, as is the case for mineral oil slicks. Mineral oil slicks are readily detected and identified by their increased reflectivity whereas the fish oil slicks which do not have a large increase in reflectivity over that of sea water, are not as detectable. The ultraviolet reflection properties of the fish oils make detection and identification very difficult. The most promising area for remote sensing appears to be the thermal IR due to the expected temperature differences in the region of fish oil slicks. Further work should investigate the energy exchange mechanisms at the fish oil ocean interface and make experimental measurements with IR thermal sensors over the ocean.

It is believed there is a good possibility for developing an infrared scanner incorporating spatial filtering which will be able to discriminate fish oil slicks on the surface of the ocean from orbital altitudes.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0141, RESEARCH NEEDS FOR REMOTE SENSING OF THE ENVIRONMENT

E.M. RISELY, Natl. Academy of Sciences, *Washington, District of Columbia*

A general study of the field of remote sensing of environment is being conducted by the NAS-NRS Committee, to determine the status of sensor technology and its application to research on the earth's environment, to provide guidance for the development of a stronger national program of research in this field, and to concentrate effort on specific problem areas.

Needs for large quantities of information on a wide range of earth environments are greater than ever. While techniques of multispectral sensing, e.g. visible, infrared, radar, and passive microwave sensing systems, are advancing very rapidly, there is a serious lag in the applications of these techniques that provides coordination of efforts at the highest scientific and governmental levels, and points the way to the fastest and most effective achievement of the required research objectives.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0142, REFLECTIVITY AND EMISSIVITY STANDARDS

J. RICHMOND, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

The technical objectives of this project are (1) to develop accurate and precise procedures for measuring thermal radiation properties of materials, particularly over the wavelength range of 0.2 to 40 millicrons, and (2) to select and calibrate standards of reflectance and emittance over the same wavelength range, and at temperatures from room temperature to 2000 K or above. The most important thermal radiation properties to be worked on are reflectance and emittance (emissivity). Such methods and standards are needed for radiant heat transfer computations, particularly in the space program, and in connection with infrared reconnaissance, particularly by D.O.D., and for remote infrared sensing as used by the Weather Bureau and Geological Survey. Major effort will be concentrated on (1) adapting existing equipment to use an available interferometer spectrometer as the monochromator-detector in thermal radiation property measurement, and (2) studying materials in an effort to find suitable standards of diffuse reflectance in the desired wavelength ranges.

The interferometer spectrometer has the potential of greatly increasing the precision of measurement and extending the wavelength range of thermal radiation property measurements. The spectrometer will be evaluated with existing auxiliary equipment, modified if necessary to overcome its limitations, or new equipment will be designed and built to exploit its advantages and overcome its limitations.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0143, RELATION OF SATELLITE DATA TO LARGE SCALE ATMOSPHERIC CIRCULATION AND ENERGETICS

J.S. WINSTON, U.S. Dept. of Commerce, Meteorology Satellite Lab. , *Washington, District of Columbia*

Technical Objectives. (a) Study of the temporal and spatial variations in long and short-wave radiation. (b) Examination of the relationship of the radiation patterns to the state of the large-scale circulation in the Northern Hemisphere; e.g., it is important to determine quantitatively how radiation patterns vary with the latitude and strength of the zonal Westerlies, within the planetary waves and also within the smaller scale waves. (c) Where extensive temperature data are available (i.e., the Northern Hemisphere) computation of the generation of available potential energy on various scales and for various regions using observed distributions of infrared and reflected solar radiation. (d) In-

vestigation of the strength, location, and time variations in the intertropical convergence zone the subtropical anticyclones, and other large-scale circulation features of tropical and extratropical regions in both hemispheres, through utilization of satellite data as indicators of broad-scale dynamic processes in the circulation. From such studies more can be learned about the interactions of the circulation between the hemispheres.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

4.0144, REMOTE SENSING OF ESTUARINE WATER AND VEGETATION, MARYLAND

R.R. ANDERSON*, U.S. Dept. of Interior, Water Resources Division, *Washington, District of Columbia

Purpose: To determine which film or film-filter combinations will provide the most information in aerial reconnaissance of estuaries ecosystems.

Methods: Correlate physical and chemical aspects of the estuarine environment with photographic and imaging characteristics on various types of films. The ultimate goal of the project is to be able to identify major plant communities associated with estuaries and evaluate water quality conditions both directly and indirectly using indicator plant species as a guideline.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0145, OIL LEAKS AND SLICKS

W.A. FISCHER*, U.S. Dept. of Interior, Fed. Water Pol. Contr. Adm. , *Washington, District of Columbia

Objective: Purpose of the study will be to determine the feasibility of detecting oil escaping from sunken wrecks and being discharged from other vessels in inland and near-shore areas by the use of remote sensors in aircraft and in spacecraft, and to apply knowledge gained toward the modification and design of equipment to perform the required tasks.

Approach: Studies will be performed based on data to be acquired in the ERA Program from Gemini and from other past and future missions for data by earth pointing space observational systems. Primary instruments will be photographic cameras with varied film and filter combinations, ultraviolet and infrared scanning spectrometric and imaging systems, and absorption spectroscopy instruments.

Success in these studies would be of vital importance toward the protection and preservation of human life against explosion and fire hazards, the protection of recreation areas, fisheries, shore and marine birds, and sources of water supply against contamination and ruin.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0146, APOLLO TEST SITE EXPERIMENT

***C.J. ROBINOVE*, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242**

Objective: Determine the use of sensors in Apollo applications experiments for hydrologic uses such as estuarine hydraulics, lake development, ground-water exploration, snow-field hydrology, and water pollution.

Approach: Based upon the results of aircraft testing of sensors and use of aircraft data in the above fields of hydrology, selected testsite investigators will extrapolate their results to larger areas of the United States and other countries and will design data-use experiments for support of selected sensors in the Apollo Applications Program. The data-use experiments will also include requirements for spatial and spectral resolution, frequency of target coverage, and other instrument and mission parameters constraining the use of the data.

Status: Previous data-use experiments submitted to NASA (i.e., photographic, radar, and infrared) will be updated in their requirements, new test sites will be chosen, and new investigators will be selected. Success of this effort will depend upon both the success of aircraft data-use experiments and future plans of NASA in the Apollo Applications Program.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0147, WATER PHYSICS AND CHEMISTRY

***C.J. ROBINOVE*, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242**

Approach: Conduct theoretical, laboratory, and empirical (test- site) investigations of the responses of water bodies to active and passive remote sensing. For example, 1) determine the use of infrared radiometry and imagery for measurement of evapotranspiration, 2) determine the extent to which quantitative measurements of thermal pollution can be made by use of infrared imagery, 3) evaluate the use of photography and imagery for mapping the hydrodynamics of estuaries and lakes, 4) assess the use of lasers in water-quality data collection and 5) investigate the use of simulated luminescence detectors in hydrodynamic mapping.

Status: Several projects are in operation in '68 FY; one report is being transmitted to NASA, several others are in preparation. Basic infrared imagery investigations have been successful and are leading to more detailed investigations of the use of infrared imagery. Combinations of photography and imagery are proving to be highly useful in mapping current patterns and hydrodynamic features in water bodies.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0148, AERIAL SEA SURFACE TEMPERATURE SURVEYS OF U S. COASTAL WATERS

M. LIGHT*, U.S. Dept. of Transportation, Oceanographic Unit, *Washington, District of Columbia

Since 1963, the U. S. Coast Guard has furnished aircraft services to the Bureau of Sports Fisheries and Wildlife in support of monthly sea surface temperature surveys of U. S. coastal waters. Temperature data collected during these surveys are utilized in ecological studies; specifically to help explain the influence of temperature on the distribution of migratory fishes and upon seasonal cycles of ocean productivity. Charts are issued at the end of each series of flights, depicting the flight paths and contours of surface isotherms.

The standard U. S. Coast Guard search and rescue aircraft, the Grumman HU16E is being used for these operations. Surface water temperatures are detected with a Barnes infrared thermometer sensor aimed through a small hatch in a rear window. A moving strip chart recorder is used to record temperature readouts.

Monthly survey flights are made over coastal waters along the East Coast between Cape Cod and Miami, and along the West Coast between the Vancouver Islands, British Columbia and Northern Baja California, Mexico.

During FY-1970, plans are for the U. S. Coast Guard to assume primary responsibility for the program. Eventually, it is planned to expand the present monthly flight coverage to include Sable Island to Key West along the East Coast, Aleutian Islands to Baja California, Mexico along the West Coast, the Bering Sea, the Gulf of Mexico, and the Great Lakes.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0149, FISHERIES RESOURCES IDENTIFICATION AND ASSESSMENT

J.W. SHERMAN*, U.S. Navy, Oceanographic Office, *Washington, District of Columbia

OBJECTIVES: (1) To develop the applications of remote sensors to locate (directly or indirectly) and quantify commercial fisheries stocks and (2) determine the methods for integrating these results into a fisheries research, development, and forecast program.

APPROACH: (1) Obtain and analyze color photography by color separation techniques for locating fish schools and/or fish environments, (2) Study the applications of multi-spectral photography aerial fishery surveying, (3) Study the feasibility of spectroscopy and spectrophotometry for locating fish and fish oil slicks, and (4) Determine the effectiveness of three color microdensitometry to assess aerial photographs of fish schools. Sensors - a. Color Photography; b. Multi-band Photography; c. Spectrometers; d. Spectrophotometers; e. Infrared Scanner; f. Multi-spectral Scanner. Proposed Contractor - Bureau of Commercial Fisheries - Sub-Contracts: Philco-Ford (Ross) - Barringer

PROBLEM ADDRESSED: There is evidence that fish schools can be detected from aerial and space photography. The use of spectrometers and spectrophotometers to detect fish, fish oils, chlorophyll, and water color correlation need to be tested and evaluated. The techniques of optimum analysis by color enhancement, color slicing, densitometry, and spectral correlations needs to be studied. Specfically, spectral bands need to be determined for: a. maximum contrast of fish schools and background; b. optimum depth penetration; c. spectral reflectance difference for various species and surrounding media, and d. target to background contrast for different water masses.

BENEFITS: The demand for fish and fish products is dramatically increasing each year. Per capita consumption based on population and income projections indicate the demand will increase 134% by the year 2000. The constraints of shipboard and airborne searching can be reduced using space as a search tool to supplement present methods.

OTHER SUPPORT: 1. NASA aircraft - photography and infrared data; 2. Shipboard Ground Truth (BCF ships);

OTHER EFFORTS: 1. TRW Systems Spectrophotometer; Philco-Ford color photography enhancements; 3. MIT color photo work; 4. WHOI studies; 5. NAVOCEANO Research Aircraft studies.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0150, FISHERIES OCEANOGRAPHY AND ENVIRONMENTAL ASSESSMENT AND PREDICTION

J.W. SHERMAN, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

OBJECTIVES: (1) To determine the effectiveness of presently available remote sensing instruments to supply pertinent data on marine fisheries; (2) to evaluate those remote sensing techniques which have the ability to indirectly locate, identify, and quantify fisheries stock.

APPROACH: (1) To define ocean environmental features pertinent to fisheries using ground truth measurements concurrent with aircraft and/or spacecraft overflights of the following oceanic phenomena: (a) wind slicks, (b) bioluminescence, (c) oceanic fronts and productivity, (d) thermal-biological aspects, (e) upwelling, and (f) divergence/convergence zones. (2) Compilation of comprehensive bibliographies related to remote sensing of fisheries environments and automated handling of space and aerial acquired data. (3) Analyze ATS and APOLLO imagery for oceanic phenomena related to fisheries. (4) Study telemetering of environmental data related to fisheries.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0151, SPECTRAL SIGNATURES OF FISH SCHOOL IDENTIFICATION

J.W. SHERMAN, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Approach: Lab tests over known fish samples will continue to be tested. In addition an airborne version of the spectrometer will be flown in the NASA aircraft concurrent with surface vessels taking surface fish and oil slick samples. Spectrometer signatures of fish oils and vapors will be cataloged. Feasibility for spaceborne application of spectrometer will be studied. a. Sensors - Airborne adaptation of absorption spectrometer. b. Proposed Contract - Barringer Research Ltd., Toronto, Canada. c. Allocation of Resources - Professional Manpower, 35%; Equipment, 35%; Overhead, 30%.

Problem Addressed: A previously funded NASA (SPOC) study has indicated a unique application of Barringer's correlation techniques for identification of various fish and mineral oil on water surfaces. The work was confined to the UV portion of the spectrum but should be expanded to include the near IR. The remote detection and identification of fish oil slicks needs to be tested from aircraft to establish possible feasibility from space.

Benefits: Remote determination of fish vs. mineral oil slicks and subsequent delineation of fish schools.

Other Support: a. Shipboard 'Ground-Truth' Equipment - work in conjunction with Bullis at BCF, Pascagoula, Mississippi. b. 2-3 test flights with NASA aircraft during FY 69-70 likely.

Other Effort: Final report from FY 67 studies received in February 1968. Support for UV measurement of major reflective differences in fish and mineral oils supported by 45K NASA (SPOC) contract will continue thru 1968 and 1969 with emphasis toward airborne testing of spectrometer.

Length of Time for this Study to Provide A Spacecraft vs Aircraft Capability: Determination of feasibility should be completed within two years.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0152, FLIGHT TESTING OF HIGH PERFORMANCE WIDE-RANGE IMAGE SPECTROPHOTOMETER (WISP) SYSTEM

J.W. SHERMAN, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

OBJECTIVE: (1) To develop an optical system expressly to perform objective remote water color measurements, (2) to gather data via airborne flight tests to proceed with the development of the WISP (Wide-Range Image Spectrophotometer) into a space qualified system, (3) To gain experience in the operation of the WISP system and associated data collection and reduction, (4) To perform an experimental investigation of ocean color measuring requirements.

PROBLEM ADDRESSED: Accurate charting of ocean color can be correlated to depth plankton content, chlorophyll, sediment, pollution, etc. The TRW study is addressed to developing the instrument, operation, and data processing requirements needed to give the oceanographer an analytical tool to observe and assess the ocean by color mapping.

BENEFITS: The color of ocean water in the past has not been measured objectively. Secchi disks and a 10-point Forel color scale have been used to describe ocean color. These methods are highly subjective and dependent on various human eye estimates to delineate a broad color band in the visible spectrum. An objective method of accurately noting ocean color numerically in narrow bands opens up a whole new field for correlating ocean color to ocean properties. Furthermore, TRW proposes to plot and contour ocean color via computer techniques with 'surface truth' available; the study of chemical, biological and sediment content; depth slicks, water mass delineation; fresh/saline water ratios and other ocean properties to ocean color could be a major ocean measurement tool. The color of water is known to be applicable to fisheries locations (water mass boundaries, upwelling, etc.) Rapid global assessment of water color in oceanography should advance knowledge thru color correlations--the applications to oceanography seem particularly appropriate because its dynamic and changing character require the rapid, broad, and repetitive coverage afforded by space vehicles.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0153, INFRARED RADIOMETRY FOR SURFACE HEAT FLOW

J.W. SHERMAN, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objective: (1) To determine a technique of measuring the total heat flux from the sea using two-wavelength infrared radiometry. (2) To establish the feasibility of using this technique on an airborne platform.

Approach: a. Sensors - A two-wavelength infrared radiometer system owened by Scripps Institution of Oceanography 3.5-4.05 microns; 4.45-5.1 microns. b. Contractor - Scripps Institution of Oceanography. c. Allocation of Resources - This effort is supported by the Office of Naval Research (1/3), the National Science Foundation (1/3), and the NASA ERS Spacecraft Oceanography Project.

Problem Addressed: Prominent oceanographers such as Pierson and Neumann (NYU) and M. Timofeev (USSR) recognize the importance of establishing a direct method of measuring heat flow from the ocean surface. Pierson and Neumann note 'the work of McAlister and others who have contributed to the development of this (infrared radiometry) technique has profound implications in both oceanography and meteorology.' Timofeev says 'The use of infrared techniques in the determination of the temperature gradient in a surface water layer was first suggested and realized by McAlister.'

4. SURVEY AND PREDICTION

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0154, REMOTE SENSOR SYSTEMS INTERGRATION AND PRESENT OPERATIONS DESCRIPTION

J.W. SHERMAN, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

OBJECTIVE: (1) To describe and analyze the present commercial method in the mission of searching for and capturing fish; (2) To evaluate the role of air and spaceborne remote sensors and define their optimum applications for this mission.

APPROACH: A thorough study of operational procedures and techniques of commercial and other fishermen in locating and capturing fish will be made. The role of the environment and its prediction will be carefully analyzed. The optimum applications of remote sensing systems to the fishing environment and fishing operation will be evaluated and defined. a. Sensors - a. Infrared Radiometry; b. Photography; c. Spectrophotometry; d. Spectroscopy.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0155, AIRBORNE REMOTE SENSING OCEANOGRAPHY PROJECT

J.C. WILKERSON, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objective: Develop and implement Navy-wide plan to produce improved remote sensors for all-weather airborne and spacecraft-borne ocean surveys. Convert NAVOCEANO aircraft to multi-purpose oceanographic/hydrographic and geophysical aircraft. Conduct airborne remote sensing experiments.

Approach: Evaluate DOD, NASA, ESSA oceanographic satellite programs; conduct laboratory and field experiments in conjunction with the above programs to acquire and interpret ocean data from spacecraft and aircraft. Identify potential methods for integrating ocean data from spacecraft and aircraft into Navy systems. Conduct experiments from aircraft on an opportunity basis to evaluate oceanographic applications of remote sensing techniques for use in Navy ocean projects. Collect, analyze, and disseminate acquired data and publish scientific and technological conclusions.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0156, EXPERIMENTAL SEA ICE OBSERVATIONAL TECHNIQUES

W.I. WITTMANN, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objective: To develop and apply airborne/satellite remote sensor systems, observation procedures and imagery interpretation techniques, surface telemetering sensors, and data acquisition methodology for observation of sea ice features, motion, deformation, and related environmental parameters.

Approach: Continue development, test, and evaluation of: (1) remote sensing systems, observation procedures, data collection methodology, and imagery interpretation techniques; (2) Interrogation, Recording and Location System (IRLS) by agreement with ONR, in conjunction with NASA NIMBUS satellite.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0157, SPACECRAFT OCEANOGRAPHY

H.J. YOTKO, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objective: To provide manpower for managing and conducting research studies in the use of remote sensing techniques applicable to oceanography and marine technology. To define suitable instrumentation and air and/or spaceborne platforms for oceanographic observations and measurements through research and experimentation.

Approach: The Spacecraft Oceanography Project provides a small highly trained scientific management staff to plan and direct in-house and contractual studies to carry out the objectives of this work unit. In addition to research studies by nationally known specialists, a program to conduct and coordinate laboratory and field experiments using NASA, DOD, university, and industrial remote sensing aircraft and laboratory facilities is carried out. The Project documents the results of studies and experiments funded by NASA/Navy SPOC Project as well as related work not funded through the SPOC Project.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0158, RESEARCH FLIGHT FACILITY

H.J. MASON, U.S. Dept. of Commerce, Research Flight Facility, *Miami, Florida*

Specially instrumented aircraft consisting of two DC-6's, one C- 54, and one Martin B-57 are maintained and operated to obtain in-flight measurements of meteorological parameters in support of the research of the Research Laboratories, other government agencies, and non government organizations whose research is government supported. Much of the flight activities is in support of the research of the National Hurricane Research Laboratory, the National Severe Storms Laboratory, and the Experimental Branch of the Atmospheric Physics and Chemistry Laboratory. The Facility also develops meteorological instruments for measurements from aircraft in response to research requirements of the above groups, and has the responsibility for installation of special equipment used by the various research groups.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

4.0159, REPRODUCTION AND FECUNDITY OF TUNAS

W.J. RICHARDS, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab. , *Miami, Florida*

This study will attempt to gain knowledge of the spawning behavior of the Atlantic tunas through analysis of the growth of ova after the methods developed by Thompson, Clark, Shaefer, and June. Randomized samples of the ovary are weighed, the mature ova present are then enumerated, and the fecundity computed.

This study was begun in FY 1966 with the study of gonad samples from yellowfin and skipjack tuna captured on GERONIMO and UNDAUNTED tuna-oceanography surveys and from shore-based sampling at Puerto Rico and West Africa.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0160, REMOTE SENSING, GULF COASTAL AREA, CENTRAL FLORIDA

R.N. CHERRY, U.S. Dept. of Interior, Water Resources Division, *Tallahassee, Florida*

Purpose - To develop criteria utilizing remote sensing techniques to identify areas where fresh water is likely to occur in an aquifer in near-shore areas.

Methods - An aerial survey will be conducted to sense the thermal contrasts of aquifer and sea water under at least four conditions- during high and low tides in a period when fresh water stages are high and during high and low tides when fresh water stages are low.

Water temperatures, water velocity, and specific conductance of water from submarine springs previously located will be determined. The water stages of fresh water and sea water will be recorded. These determinations will be compared with remote sensing data which indicate submarine discharge and the relative position of the zero piezometric contour.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0161, REMOTE SENSING, EVERGLADES AREA, FLORIDA

M.C. KOLIPINSKI, U.S. Dept. of Interior, Water Resources Division, *Tallahassee, Florida*

Purpose: To determine the relations between water conditions and biological populations in the Everglades by interpretation of airborne data and to develop new applications in natural resources research for data from remote sensors.

Methods: Spectral reflectance measurements of floral communities and water will be obtained using an airborne 18-channel optical- mechanical scanner. The data will be accumulated in a form that will allow use of a computer to identify and map the distribution and amount of selected communities. Remote sensing data will be examined for potential in: detecting plankton blooms, locating alligator holes, and estimating populations of large animals.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0162, EXCITED STATES MECHANISMS IN PHOTOBIOLOGY

W.D. MCELROY, Johns Hopkins University, Graduate School, *Baltimore, Maryland* 21218

Technical Objective: To expand level of support of photobiology into mechanism of bioluminescence, chemiluminescence involving molecular oxygen; fluoresence polarization in analysis of protein and polypeptide structure, quenching, investigation infra-red emission of highly conjugated molecules; biological reactions initiated by light.

Approach: Design and construct specialized high sensitivity photon detection equipment for visible and infrared regions of the spectrum; investigation evolutionary aspects of bioluminescence. Studies of energy transfer and oxygen photochemistry; construction equipment to measure excited state short lifetimes (1-10 nanoseconds).

Progress: a. b. d. e. of the formation of excited states of molecules as the result of chemical transformation of energy, with particular attention to mechanisms of bioluminescence, chemiluminescence, quantitative measurement of quantum yields and emission spectra of fluorescence and bioluminescence.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0163, AIR OCEANOGRAPHY

G. EWING, Woods Hole Oceanographic Inst., *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

This task is concerned with the development and utilization of aircraft and satellites in studies of oceanic phenomena. This year emphasis is upon the development of a free floating buoy system for the Nimbus IRLS experiment to be flown in spring 1968. The feasibility of tagging and monitoring daily the location of an eddy shed from the Gulf Stream by satellite will be determined. This also will complement work concerned with the dynamics of such eddies.

The capability to obtain environmental data from airborne sensors has potential for providing such information to Naval operations rapidly and in areas where it might not otherwise be available.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0164, SENSING OF ENVIRONMENT

G. ZISSIS, Univ. of Michigan, Institute of Sci. & Technology, *Ann Arbor, Michigan*

This task consists of research on remote sensing environment determination of state-of-the-art, and dissemination of knowledge and techniques through interdisciplinary symposia where progress in the field of remote sensing is facilitated by exchange of information among environmental scientists, physical scientists, engineers, and instrument specialists.

The increased understanding of emission and reflection of electromagnetic energy from the earth's surface, when coupled with the vast quantities of environmental data which can be obtained with remote sensing systems, will greatly improve our ability to rapidly assess actual ground conditions in land, water, and air environments.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0165, EFFECT OF TEMPERATURES AND CIRCULATION OF CONTINENTAL SHELF WATERS ON THE DISTRIBUTION OF FISHES

R.B. STONE, U.S. Dept. of Interior, Sandy Hook Marine Lab., *Highlands, New Jersey*

Description of Work: Conduct monthly aerial sea surface temperature surveys over Atlantic Shelf from Cape Cod, Mass., to Cape Fear, N.C. in Coast Guard aircraft. Additional flights will be made when necessary to compliment game fish research in other areas of the Atlantic shelf. Flights will be coordinated where possible with cruises of research vessels to obtain reference surface and subsurface temperature data. Monthly isotherm charts will be produced and will include observations of fishing vessels, surface schooling fishes, large pelagic fish, marine mammals and other marine animals. An attempt will be made to correlate the catches of migratory game fish by sport and commercial fishing vessels with observed sea surface temperature patterns. Surface and bottom current drifters will be released at 10- mile intervals along transects normal to the coastline.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0166, MULTISPECTRAL SENSING OF COASTAL ENVIRONMENTS

E.P. YOST, Long Island University, Graduate School, *Brookville, New York* (N00014-67-C-0281)

A four-band airborne multispectral photographic system is being tested for its ability remotely to determine shallow water depths, bottom characteristics, and other aspects of coastal and near-shore environments. Films and filters have been selected so that blue, green, red and infrared portions of the spectrum are being sampled for the remote sensing tests. Camera, instruments and test targets have been calibrated, prior to ground and air borne field testing of the system over controlled coastal test sites.

The improvement of multispectral sensing techniques resulting from this research has direct application to a wide range of remote environmental envestigations. Faster, more accurate methods of determining beach characteristics, presence of underwater obstacles, and depth of shallow water will assist operations in coastal environments.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0167, PROJECT AQUA-MAP - DEVELOPMENT OF AERIAL PHOTOGRAPHY AS AN AID TO WATER QUALITY MANAGEMENT

G.J. NEUMAIER, Cornell Aeronautical Lab. Inc., *Buffalo, New York* 14221

In this program, laboratory experiments were performed to determine the feasibility of using aerial photographic techniques for water resources research; in particular, for detecting, classifying and measuring concentrations of effluents. The spectral reflectance characteristics of several effluents were measured and suggestions were made for optimizing the detection and identification of these discharges. In addition, factors influencing the selection of sites for aerial photographic experiments were analyzed. The Finger Lakes and Lake Chautauqua were considered as well as the Niagara Frontier. The study indicated that it is feasible to enhance the photographic contrast of discharges with respect to their backgrounds, and with appropriate controls, to use spectral signatures for classifying types of discharges and for measuring concentration over certain ranges.

Phase II: In this phase of the AQUA-MAP program, aerial photographic flights are being conducted in the Buffalo area over the Niagara River and Tonawanda Creek. The types of discharges imaged are being studied in the laboratory under controlled conditions. Additional laboratory measurements have been made of the spectral reflectance characteristics of water samples taken from the Niagara River and Tonawanda Creek to supplement the data obtained during Phase 1 on discharges.

Theoretical investigations into the mechanics of scattering by polluted aqueous solutions are being examined. Laboratory and aerial validation of the theory are being performed, the intent being to allow a realistic model of the polluted bodies of water to be created. Such a model will serve to aid the identification of pollutants via aerial photographs and also indicate the limitations of remote sensing analysis.

SUPPORTED BY New York State Government

4.0168, REMOTE SENSING OF DELAWARE ESTUARY

R.W. PAULSON, U.S. Dept. of Interior, Water Resources Division, *Harrisburg, Pennsylvania* 17104

4. SURVEY AND PREDICTION

Purpose: To determine effectiveness and feasibility of remote sensing devices in estuarine hydrologic investigations.

Methods: A series of remote sensing data collection missions will be flown over the Delaware estuary by NASA and USGS aircraft. Sensitivities of sensors to water quality variations will be treated initially. Subsequent missions will be based on initial findings.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0169, COORDINATION OF ESTUARINE REMOTE SENSING IN ATLANTIC COAST REGION

R.W. PAULSON, U.S. Dept. of Interior, Water Resources Division, *Harrisburg, Pennsylvania* 17104

Purpose: To provide an overview of Atlantic Coast estuaries, now that it is practical to photograph or sense at frequent and regular intervals large areas of the earth's surface from space. To develop a program and modi operandi for studying estuaries and groups of estuaries from space.

Methods: Photographs, remote sensing data and other information from individual remote sensing projects will be compiled, collated, and coordinated to formulate an optimal synoptic approach to the study of the hydrology of estuaries from space.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0170, REMOTE SENSOR OCEANOGRAPHY

L.R. CAPURRO, Texas A & M University System, Graduate School, *College Station, Texas* 77843 (NONR)

The basic areas of research of this task are: (a) to develop techniques whereby oceanographic features peculiar to the Mississippi Delta area may be investigated by using remote sensors; (b) to develop techniques for making conclusions about the character of the sea surface utilizing aerial and space photographs of clouds as well as other imagery of them including NIMBUS, IR and TV; (c) to develop methods of determining sea surface temperature patterns from IR imagery and radiometry in the presence of random, transitory cloud systems partially interfering with the field of view.

The sensing and interpreting of oceanographic and other environmental data from satellites is of significant potential value for acquiring such data on a global basis or in remote areas for environmental prediction purposes. The results of this task are expected to contribute to this developing capability.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0171, REMOTE SENSING

G.L. HUEBNER, Texas A & M University System, Graduate School, *College Station, Texas* 77843 (NONR)

The objective of this task is to determine the microwave characteristics of sea water and ultimately the optimum frequencies for oceanographic radiometry. Laboratory measurements are being made too over the frequency range of 1,000 to 30,000 megahertz. Aside from examining sea water over various salinity and temperature values, contaminants such as surface oil films, dissolved clay particles and dissolved gases are being studied to determine their effects on the microwave properties of sea water.

The possibility of using infrared remote sensing devices has been examined extensively but never fully resolved. The fundamental mechanisms are not understood. These studies should contribute to that understanding and, in addition, are necessary to the successful use of remote sensor determinations of ocean currents upwelling, and other oceanic processes reflected in surface temperature measurements.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0172, SPACE APPLICATIONS TO FISHERIES OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM)

J.S. BAILEY, U.S. Dept. of Interior, Biological Laboratory, *Fort Crockett - Galveston, Texas*

It is necessary to know what conbinations of remote sensors suitably delineate known oceanic features and to establish the uniqueness of these instruments in the various combinations. A catalog of the spectral 'signatures' in terms of the recorded energy distributions must be acquired so that conditions measured can be related directly, and quantitatively to the structure of the surface layers (top 400 meters) of the ocean.

Project goals are to (1) delineate those ocean features, in space and time, that are significant to the support of given fisheries; (2) accumulate and synthesize historical data to provide the basis of a computer program to relate catch to oceanic condition; (3) develop programming techniques to implement oceanic (fishery) survey systems aboard satellites (unmanned orbiting vehicles); and (4) accurately forecast, in an appropriately workable time frame, fishery dynamics for the proper exploitation of these fisheries.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0173, UTILIZATION OF SYNCHRONOUS SATELLITE DATA

V.E. SUOMI, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

Objectives: Develop methods of utilizing meteorological data from synchronous satellites and the conception of new techniques for observing and interpreting the state of the atmosphere to meet the requirements for global atmospheric research and prediction.

Approach: The geostationary satellites provide an opportunity to exploit the quantitative imaging of weather patterns on the Earth. ATS-I and ATS-III images of the Earth and cloud cover offer opportunities to determine wind velocity by cloud displacement analyses, cloud height estimates, and develop methods of utilizing the observation of sun glint upon the ocean surfaces. The analyses of these phenomena will lead to the extension and interpretation of the presently available observations and the development of new techniques for determining the status and structure of the atmosphere.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4I. ECONOMIC ANALYSIS

(General Studies. Specific Economic Analyses Found Under Subjects Being Studied.)

4.0174, ANALYSIS OF THE EFFECT ON OPERATING COSTS AND RETURN ON INVESTMENT OF VARIATIONS IN OPERATING PARAMETERS

M.J. CRUICKSHANK, U.S. Dept. of Interior, Marine Min. Technol. Ctr., *Belvedere - Tiburon, California* 94920

To evaluate the importance of individual components in a mining system, their effects on the system must be known. Operating costs and return on investment are both important measures by which the efficiency of a mining system is evaluated. By analysis of the cash flow for an operation, the effects of variations in environmental or technical components may be determined. Computer will be used for these determinations.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

4.0175, 149A FISHERY SYSTEMS ANALYSIS

R.E. GREEN, U.S. Dept. of Interior, Fishery Oceanography Ctr., *La Jolla, California*

The objective of this project is to determine what management practices may be most efficient in increasing the cost effectiveness of the wetfish fishery, consisting of a fleet of small fishing vessels working the coastal region of California and the distant-water tuna purse seine fleet, both presently economically unsound.

Analysis of the cost/earnings structure of the tuna purse seiners recently completed, has been useful in understanding the economics of that fishery; it is proposed to apply similar techniques to the wetfish fishery. Computer simulation studies will also be made on these fisheries to determine effects of various predictable factors on the efficiency and profit of the fisheries.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0176, STUDY OF OCEANOGRAPHIC MARKETS

J. GOLDEN, Planning Research Corporation, *Los Angeles, California*

In this project, PRC conducted a developmental study of oceanographic markets for a large industrial manufacturer of specialized equipment and chemicals.

PRC reviewed all oceanographic markets -- military and commercial -to provide rough-cut forecasts of future potential for the client's advanced equipment, services, and consumables; and to identify project areas of potential interest to the client.

Client capabilities, interests, and limitations were assessed in order to determine projects that would be especially suitable, and to select action for implementing specific projects. Detailed recommendations for project implementation were included.

SUPPORTED BY Industrial Manufacturer

4.0177, MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY

R.C. SMITH, Univ. of Delaware, Agricultural Experiment Sta. , *Newark, Delaware* 19711

Objectives: 1) To determine the product flow and existing characteristics fo the commercial fishing industry and its relative importance in the Northeast, 2) To analyze the dynamic aspects of the supply and demand situation for the major species of finned fish and shellfish of the Northeast, and 3) To assess implication of potential changes in the market structure and its performance on the fishing industry, poultry and livestock producers and consumers.

Description of Work Proposed: The Delaware station will concentrate primarily on studying menhaden and other fish used in animal feeds. The first procedural step will requrie the compilation of data related to the distribution of menhaden fish including the primary markets, marketing channels and product use by poultry and livestock.

Estimates of supply and demand parameters for menhaden fish will be obtained. Statistical procedures including linear programming and single equation regression models will be used to evaluate the relationship fo fish meal to poultry and livestock production.

SUPPORTED BY U.S. Dept. of Agriculture
Delaware State Government

4.0178, ECONOMICS OF NUCLEAR FUEL

UNKNOWN, N U S Corporation, *Washington, District of Columbia* 20036

Purpose: To establish a frame of reference for assessment and projection of the costs of nuclear fuel for merchant ships.

Description: A detailed investigation has been made of the economics of nuclear fuel as a source of energy for merchant ships. The initial studies made under this contract have been reevaluated and updated to incorporate latest cost estimates. The research consists of evaluation of currently proposed pressurized water maritime reactor core design; identification of significant costs; projection of costs based on past and present levels; and comparison of cost trends with selected central station reactors that employ similar fuel technology. The results will be put in a form that can be used in making an economic assessment of commercial nuclear ships.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

4.0179, MARINE TRANSPORTATION ECONOMIC ANALYSIS

P.B. MENTZ, U.S. Dept. of Commerce, Maritime Administration, *Washington, District of Columbia* 20235

With the objective of outlining a formalized approach to selection of appropriate economic criteria and use of realistic costs of capital in the conduct of marine transportation analysis, this study reviews the available economic criteria for financial decision making. Among those considered are the internal rate of return, life cycle cost, required freight rate, net present value, and net cash flow indices. Use is made of the concepts of 'opportunity-limited' and 'capital limited' corporate environments in reaching the application-oriented conclusions.

This is followed by a discussion of the cost of capital for corporate investment in shipping operations. An in-depth corporate model is developed and results presented for various sets of input parameters describing the components of such financial structures. The model has been programmed in Fortran IV and is being run on a Honeywell 200 computer.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

4.0180, DETERMINATION OF THE STRUCTURE & ECONOMIC IMPORTANCE OF THE VARIOUS SEGMENTS OF THE SEAFOOD INDUSTRY

D.H. CARLEY, Univ. of Georgia, Agricultural Experiment Sta. , *Athens, Georgia* 30602

Objectives: To determine the structure and economic importance of the various segments of the seafood industry of Georgia including: a. Volume, trend and seasonality and value of landings of fish and shellfish. b. Number employed, and wages and earnings in various segments of the industry. c. Capital investment in facilities and equipment. d. Expenditures for supplies and services.

Procedures: Secondary and primary data, including personal interviews of fishermen, processors and industry representatives, will be used to fulfill the objectives. Budgetary and other quantitative techniques will be used in this phase of the study.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Georgia State Government

4.0181, FISHING VESSEL CONSTRUCTION COSTS AND THE U.S. FISHING VESSEL CONSTRUCTION DIFFERENTIAL SUBSIDY

C. HAMLIN, Ocean Research Corporation, *Kennebunk, Maine* 04043

The purpose of this study was to establish valid, directly comparable, fishing vessel construction costs, to review the present system of setting fishing vessel construction subsidies paid by the Federal government, and to make recommendations for improvements to this system. Direct shipyards costs of building fishing vessel were obtained, by personal visit, from yards in the U.S., Japan, W. Germany, Norway, Netherlands, and U.K. Cost comparisons on the basis of cubic number (LWL x Beam x Depth), vessel type, construction material, and country of build, were established, and a formula devised for suggested use in establishing subsidy percentages at the preliminary design stage.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0182, ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST

UNKNOWN, Univ. of Maryland, Agricultural Experiment Sta. , *College Park, Maryland*

1. To determine the product flow and existing characteristics of the commercial fishing industry and its relative importance in the Northeast, 2. To analyze the dynamic aspects of the supply and demand situation for the major species of finned fish and shellfish of the Northeast. 3. To assess the implications of potential changes in the market structure and its performance on the fishing industry, poultry and livestock producers, and consumers.

DESCRIPTION OF WORK PROPOSED: The Maryland contribution will relate to all three objectives. Secondary data will be compiled related to the product flows and structure of the fishing and seafood processing industries in the Chesapeake Bay Area. Factors effecting the supply of both fresh and processed fishery products from the Chesapeake Bay Area and the factors effecting the demand for these products will be

. oysters, and clams. In the third phase the effects of expected structural changes and probable changes in selected exogenous variables on the employment, output, other economic variables in the industry will be assessed.

SUPPORTED BY U.S. Dept. of Agriculture
Maryland State Government

4. SURVEY AND PREDICTION

4.0183, ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST

UNKNOWN, Univ. of Massachusetts, Agricultural Experiment Sta., *Amherst, Massachusetts* 01003

Objectives: 1. To determine the product flow and existing characteristics of the commercial fishing industry and its relative importance in the Northeast. 2. To analyze the dynamic aspects of the supply and demand situation for the major species of finned fish and shellfish of the Northeast. 3. To assess implication of potential changes in the market structure and its performance on the fishing industry, poultry and livestock producers, and consumers.

Massachusetts will determine consumer demand for haddock, cod, redfish, whiting, and flounder using cross-section data obtained from a sample of consumers.

SUPPORTED BY U.S. Dept. of Agriculture
Massachusetts State Government

4.0184, SECOND HAND PRICES FOR TANKERS

P.A. EMBIRICOSCOUMO, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

The purpose of this thesis is to describe the mechanics of the second hand market in oil tankers. Since the value of an oil tanker depends upon the value of its flow of services, the market for tanker transportation services is examined in detail. This examination reveals that although the oil companies have enough market power to maintain stable rates under normal conditions they hedge against unexpected market changes by engaging in a substantial portion of the available tonnage under long term contract. This results in a very thin market for the tonnage that is free of long term commitments. This latter market, called the spot market, is thus subject to fluctuations which, in turn, are responsible for large fluctuations in the value of tonnage free of long term contract.

In order to clarify the movements of the market for used oil tank ships a theoretical model was developed through which first, the conditions for equilibrium of the market were derived and second, the adjustment behavior of the market was traced. Expectations were explicitly introduced into the model. A time series of prices and transactions was compared to the theoretical conclusions, and found to compare favorably.

The importance of short run expectations having been confirmed, the influence of long term expectations was investigated. It was determined that the increasing change in technology has resulted in the greater importance of long term expectations of transportation rates on the level of oil tank ship prices.

SUPPORTED BY Massachusetts Institute of Technology

4.0185, FINANCING OF FISHING VESSELS

A. HOLMSEN, Univ. of Rhode Island, Agricultural Experiment Sta., *Kingston, Rhode Island* 02881

Availability of funds at reasonable terms for financing of fishing vessels seem to be one of the most important factors responsible for the slow growth of the R. I. fishing fleet. At the present time the commercial banks charge a 6 1/2% compounded interest while in other fishing ports in New England commercial banks lend at 5 1/2% of the outstanding balance. Most banks in Rhode Island refuse to finance fishing vessels. The primary reason seems to be lack of knowledge of the risk involved and of the returns to capital in the industry.

This project will, by use of the interview questionnaire method, determine the return to capital for the various kinds and sizes of commercial fishing vessels in Rhode Island, determine how vessels are financed and the difficulties involved. A sample of vessels in Stonington, Connecticut and New Bedford, Massachusetts will also be studied to determine whether significant differences occur. The policies of the various financing institutions will be studied with respect to fishing vessel financing.

SUPPORTED BY Rhode Island State Government

4.0186, MARKET STRUCTURE OF COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST

H.C. LAMPE, Univ. of Rhode Island, Agricultural Experiment Sta., *Kingston, Rhode Island* 02881

Objectives: 1) To analyze the dynamic aspects of the supply and demand situation for the major species of finned fish and shellfish of the Northeast. 2) To assess implication of potential changes in the market structure and its performance on the fishing industry, poultry and livestock producers, and consumers.

One existing simultaneous equation model of the haddock market will be revised. Major revision will be affected in the wholesale and import equations. Particular efforts will be made to obtain measures of the transactions associated with cold storage holdings and the prices at which transactions are made. In addition the revision will seek to avoid the problems associated with movements of cold storage holdings from one location to another within a firm. A model of fish population will be coupled with the market model above to provide the basic simulator of the market population system. The dynamic properties of the system will be evaluated in successive simulator runs on a computer. The influence of changes in parameters of the markets and populations on the equilibrating properties of the system will be presented and evaluated. A preliminary simulator has been developed and will be improved.

SUPPORTED BY U.S. Dept. of Agriculture
Rhode Island State Government

4.0187, ECONOMIC IMPACT OF MARINE-ORIENTED ACTIVITIES IN THE SOUTHERN NEW ENGLAND MARINE REGION

N. RORHOLM, Univ. of Rhode Island, Agricultural Experiment Sta., *Kingston, Rhode Island* 02881

Objectives: 1. To determine the present and estimate the future amounts of human economic resources employed in marine-oriented activities of commercial, educational, research, defense and recreational nature. 2. To analyze the relationship between the marine-oriented activities and the general economy of the area including estimates of economic and employment impact.

Procedures: The initial work (Phase I) will concentrate on a detailed study of the marine-oriented activities. On the general economy only secondary data will be collected. Later phases will deal with the remaining parts of the regional economy and the region's population. Data on human resources employed, investment, costs, sales and future plans will be gathered through personal interviews. Secondary data from Sales Tax Divisions, Census of Manufacturers, Census of Business and Department of Labor will also be utilized.

SUPPORTED BY Rhode Island State Government

4.0188, CONFERENCE ON THE FUTURE OF THE U.S. FISHING INDUSTRY

R. VANCLEVE, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

A conference on the U.S. fishing industry was held in Seattle in March, 1968, under the sponsorship of the University of Washington. Its purpose was to identify the problems that beset the U.S. fisherman; the causes for the economic decline of some portions of the fish catching industry in the face of growing worlds markets; and the rising percentage of imported fish. Attendance represented a cross-section of U.S. fishing interests, university faculties, and government agencies. The contract provided for a summary report which analyzed the conference, developed conclusions of the General Committee, and presented a concensus of recommended corrective actions. This report was completed in August, 1968.

SUPPORTED BY Natl. Council on Marine Res. & Engin. Dev.
U.S. Dept. of Interior - Bu. Comm. Fish.

5. LIVING SYSTEMS (NON-HUMAN)

(see Also Chapter 7 For Engineering Aspects)

5. LIVING SYSTEMS (NON-HUMAN)

5A. FISH POPULATIONS

5.0001, STOCKING AND SURVIVAL OF STRIPED BASS FINGERLINGS

E.W. SHELL, Auburn University, Graduate School, *Auburn, Alabama* 36830

Objectives: To determine if the periodic stocking of striped bass (4 to 6 inch group) into river systems connecting estuarine areas of Alabama would establish this species at a sufficient level to allow the development of a commercial fishery.

Procecure: Large striped bass fingerlings (4 to 6 inches group) produced uper job II of the study will be stocked in selected areas determined under Job I. Fingerlings will be suitably marked so that they can be identified on subsequent recovery. Fishermen will be interviewed, and sampling will be done by seining, trawling, and by rotenone or other chemical methods to determine the survival of striped bass stocked.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alabama State Government

5.0002, KVICHAK RIVER TOTAL SMOLT

S. PENNOYER, State Dept. of Fish & Game, *Anchorage, Alaska*

A long term declining trend in the important Kvichak River fishery at Bristol Bay coupled with extreme annual fluctuations in run size demand that research be undertaken to accurately predict returning run size and estimate the annual escapement levels needed to sustain maximum yield. The present index sampling of smolt abundance has not fulfilled this need. This project will seek to estimate total annual smolt outmigration eliminating many of the sources of error in the index method and allowing quantitative evaluation of production from escapement and mortalities at various life history stages.

This phase of the study will consist of the following steps: 1) location of suitable sampling site, 2) recording of physical properties of the site, e.g., depth, width, flow, water clarity, that might affect smolt migration patterns and behavior, 3) establishment of a field camp at the site, 4) a single fyke net or similar capture device covering the same water areas as the present index net will be fished on a twenty-four hour basis at the site for comparison with present index catches. Some modifications in counting gear and fishing apparatus will be tested, 5) smolt distribution across the channel(s) will be sampled by fishing at intervals across the river with some form of mobile sampling gear and comparing counts with those of the stationary gear, 6) experimentation with various forms of capture and counting gear will be initiated to develop counting units that can be placed at intervals across the river (photo-electric grids are contemplated). The use of louvres and light for smolt guidance will also be investigated, 7) smolt behavior and reaction to various forms of gear will be studied by use of SCUBA and underwater photographic equipment.

(Part 1 of 2)

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0003, KVICHAK RIVER SMOLT STUDY LITERATURE SURVEY

S. PENNOYER, State Dept. of Fish & Game, *Anchorage, Alaska*

A long term decling trend in the important Kvichak River fishery of Bristol Bay coupled with extreme annual fluctuations in run size demand that research be undertaken to accurately predict returning run size and estimate the annual escapement levels needed to sustain maximum yield. The present index sampling of smolt abundance has not fulfilled this need. This project will seek to estimate total annual smolt outmigration eliminating many of the sources of error in the index method and allowing quantitative evaluation of production from escapement and mortalities at various life history stages.

During the first year of the project the available literature on smolt sampling and enumeration will be surveyed and correspondence with individuals involved in this type of research in other areas will be contacted. A great deal of work has been done on sampling, guiding and counting downstream migrants and some of the work done and devices tested are applicable to the Kvichak River program. This phase will continue throughout the life of the project with the main emphasis during the period January through April of 1966. The project leader and assistant will be responsible for this work.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0004, BRISTOL BAY ESTUARINE ECOLOGY

C.J. DICOSTANZO, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

During the past few years intensive work has been done on the freshwater and the high seas phases of the life history of the sockeye salmon. Recent work has indicated that the ocean survival rates may not be nearly as constant as formerly thought and that estuarine conditions strongly influence these rates. Thus it seems necessary to supplement the freshwater and oceanic studies with investigations into the ecology of the sockeye salmon in estuarine areas.

The early phase of this study will be largely exploratory in nature. The objectives are: 1. To delineate the water masses within the Bristol Bay area and determine the physical and chemical features of the estuarine and adjacent coastal waters. 2. To determine the pattern of movement and distribution of smolts from the parent river into the estuary and ocean waters. 3. To determine the growth and survival of smolts as they pass through this transitional phase of their life cycle.

The first full season of study will utilize aircraft and radiometer to delineate water masses in Bristol Bay.

More specific oceanographic studies will be conducted from a surface vessel. It is expected that much time will be spent in assembling gear and developing standard stations and technique. Sampling of juvenile salmon will be accomplished with various kinds of gear, including tow net, trawls, seins, and gill nets.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0005, NAKNEK SYSTEM RED SALMON STUDIES

C.J. DICOSTANZO, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

The Naknek River system is composed of several large nursery lakes, connected by short streams. Each lake receives stocks of adult red salmon which utilize various types of adjacent spawning grounds. Juvenile salmon migrate ocean-ward from lake to lake at various times of the year.

The objectives of this program are to obtain an understanding of the various factors influencing the abundance, distribution, survival, growth, and movement of adult and juvenile sockeye salmon in the system. The expanded program includes all studies of the former Brooks Lake research program. Several related studies are currently in progress concerning the following: 1. Determine vital statistics of red salmon adult and young fish populations through systematic collection of data pertaining to length, weights, sex fecundity, and abundance at successive life history stages. 2. Determine the direct causes of mortality and the nature of their effects. 3. Determine required population densities for optimum utilization of available spawning gravels and nursery areas. 4. Determine morphological and physiological characteristics and behavior patterns that distinguish spawning colonies. 5. Determine the effects of intra and interspecific competition. 6. Identify what measures involving manipulation of the spawning or lake nursery environments or the salmon populations themselves may result in maximizing freshwater production.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0006, KARLUK LAKE RESEARCH STATION

C.J. DICOSTANZO, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

The broad objective of the Karluk research program is to determine the cause(s) of the long-term decline in the spawning run of red salmon and to try to reverse this downward trend. To this end, investigations are directed toward identifying, enumerating, and determining productivity of subpopulations and calculating mortality rates at various atages of the red salmon life cycle.

Size, age, and fecundity of subpopulations are being studied as well as their timing, distribution, and abundance on various spawning grounds.

Adult escapement and smelt outmigration sizes are being determined and sampled to obtain vital descriptive data. We are using these data to calculate mortality rates during the ocean phase of the red salmon life cycle.

Potential egg deposits and fry productions are being determined for diverse spawning grounds so that mortality rates during that stage of the freshwater life cycle may be calculated.

Methods of indexing abundance of juvenile red salmon have been developed.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0007, CHUM SALMON INVESTIGATIONS

C.R. MATTSON, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

Salmon research by the Chum Salmon Investigation is centered at the Traitors Cove field station, which is located on Revillagigedo Island approximately 25 airline miles north of Ketchikan, Alaska. Original research emphasis, the station was established in 1960, was upon the freshwater and early marine life phases of the chum salmon, Oncorhynchus keta, life cycle. In 1964 research emphasis was shifted to the early marine life history stage of the young chum and pink, Oncorhynchus gorbuscha, salmon. This change was made because intensive freshwater and intertidal salmon research was being conducted at other field stations in Alaska. Additional factors justifying the change was the availability of two connected, enclosed marine basins ideal for estuarine salmon research, and pink salmon were included as they were available in even greater abundance than chum salmon.

General research objectives include the following: Determine relative abundance and timing of juvenile pink and chum salmon migrants from Traitors River and within the two marine basins forming Traitors Cove; study food habits of the salmon and determine availability of food organisms; determine salmon growth rates within an estuarine environment; and study estuarine environmental factors such as water temperatures, salinities, currents, and turbidities and relate these to juvenile salmon abundance and behavior.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0008, MARINE BIOLOGICAL INVESTIGATIONS - TAXONOMIC COLLECTION OF THE FRESH AND SALTWATER FISHES OF ALASKA

J.C. QUAST, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

The fish collection comprises approximately 250 species of Alaskan marine and freshwater fishes. Eventually nearly all fish species inhabiting Alaskan waters will be represented. Scientific uses include collection of growth series so that juveniles, larvae, and eggs may be identified, the accurate identification of specimens taken in research activities, and recognition and definition of new species, the accumulation of series for racial work and variation analyses, and the construction of faunal lists and keys. Museum facilities are available to investigators, and specimens are available on loan to research institutions.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0009, GULF OF ALASKA DEMERSAL FISH INVESTIGATIONS

J.C. QUAST, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

Goals of the long-term projects are (1) to assemble all available data, published and unpublished, on the physical ecology, faunal assemblages, and population parameters of the demersal fishes of the Gulf of Alaska; (2) to classify this information on the basis of the statistical grid for the North Pacific Ocean in current use by the International North Pacific Fisheries Commission and store the information in suitable form on IBM cards to allow: (3) the retrieval of information in the form of geographic and bathymetric distribution and density charts of species, the detection of faunal assemblages, the delineation of areas of high and low fish production, the assessment of future stock deterioration with fishing, and general correlation analysis to bring out salient relationships between biological, physical, and fishery factors and demersal fish production.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0010, MARINE BIOLOGICAL INVESTIGATIONS - ANALYSIS OF HERRING FISHERY DATA

J.C. QUAST, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

Analysis of data on catch per unit effort and age frequencies of Alaskan herring in the fishery. Data extending from the present to 1929. Analyses of data on herring movements in Southeastern Alaska as revealed by radioactive tagging experiments in 1960 and 1961. Preparation of manuscripts.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0011, MARINE BIOLOGICAL INVESTIGATIONS STUDIES PROJECT (FISHES)

J.C. QUAST, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

Quantitative studies of the complete fish faunas of selected bays of Southeastern Alaska. Goals: to identify the fishes and determine the ecology, density, growth, and mortality of their populations in the present nearly natural state. Such data to serve as benchmark information for comparison with future surveys of the same or similar bays of the region when these bays have been changed by man-made or natural causes. Ancillary objectives include the determination of possible faunal gradients that occur from the coast eastward in the inside waters and from north to south.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0012, MARINE BIOLOGICAL INVESTIGATIONS - JAPANESE FISHERY OBSERVERS PROJECT

J.C. QUAST, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

Goals are to monitor the take of Pacific halibut by Japanese fishery vessels in the Gulf of Alaska and to obtain catch information for possible use by the U.S. fishing industry. Project started in 1964. Approximately 300 hours of trawling observed each year.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0013, INVESTIGATION OF ANADROMOUS DOLLY VARDEN POPULATIONS IN HOOD BAY DRAINAGES, SOUTHEASTERN ALASKA

R. ARMSTRONG, State Dept. of Fish & Game, *Juneau, Alaska*

Objectives: (1) Determine the number and timing of Dolly Varden leaving Hood Bay Creek on their first migration to sea. (2) Determine the number and timing of Dolly Varden entering and leaving Hood Bay Creek. (3) Determine the number and timing of salmon entering Hood Bay Creek. (4) Determine the size, sex ratio and age of Dolly Varden migrating to sea for the first time from Hood Bay Creek. (5) Determine the size, sex ratio and age of Dolly Varden entering and leaving Hood Bay Creek. (6) Determine the homing tendencies, within the year, of Dolly Varden leaving Hood Bay Creek on their first migration to sea. (7) Determine the homing tendencies, within the year, of inmigrant Dolly Varden displaced from Hood Bay Creek. (8) Determine the homing tendencies of Dolly Varden entering Hood Bay Creek. (9) Determine the number of mature (potential spawners for the year) and non-spawning Dolly Varden entering Hood Bay Creek. (10) Determine the frequency of spawning, by sex, of Dolly Varden spawning in Hood Bay Creek. (11) Determine if mortality of char occurs after spawning and obtain an estimation of mortality rate of spawned-out char by sex. (12) To locate spawning areas of Dolly Varden in Hood Bay Creek. (13) Estimate Dolly Varden egg deposition and over-winter survival of the eggs in a selected area of Hood Bay Creek. (14) Evaluation of hydraulic sampling techniques in providing a deposition index. (15) Determine the distribution of Dolly Varden and salmon in Hood Bay Creek on a weekly basis. (16) To obtain information on the physical and chemical conditions of Hood Bay Creek. (17) Determine the food of Dolly Varden migrating to sea for the first time from Hood Bay Creek. (18) Determine a tag suitable for use on Dolly Varden less than 150 mm in fork length. (19) To evaluate the effectiveness of the Hood Bay Creek weir to stop and trap Dolly Varden on their first migration to sea.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Alaska State Government

5.0014, COOK INLET CATCH AND ESCAPEMENT AGE AND SEX COMPOSITION STUDIES

A.S. DAVIS, State Dept. of Fish & Game, *Juneau, Alaska*

The purpose of this phase of a long range sockeye study is to separate the returning adult runs by age and sex groups. The obtained information is necessary for evaluating optimum escapement indices and marine survival evaluations. Attempts to separate catch samples by river systems by scale characteristics will also be investigated.

Sampling of characteristics of the salmon caught in each of the several gill net fishing areas of the Inlet, along with spawning ground sampling for the same characteristics will be conducted at selected points.

A two-man crew will begin sampling July 1 in the set net fishery in the Ninilchik to Kasilof River area. Sampling will be conducted at the Columbia Wards Cannery at the mouth of the Kenai River when fish are available in sufficient numbers. The crew will sample set net catches on Kalgin Island, Kalifonsky Beach, Salamatof Beach, and Harriet Point on the west side of Cook Inlet. The drift net fishery will be sampled on two separate fishing days, July 21 and July 24. Spawning ground sampling will begin August 5.

Part 2 of 3

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0015, COOK INLET SMOLT ENUMERATION STUDY

A.S. DAVIS, State Dept. of Fish & Game, *Juneau, Alaska*

The purpose of this phase of a long range sockeye salmon study is to enumerate the smolt production from the Kenai River. This will allow the establishment of index values which can be related to total smolt run size and will enable estimates of fresh water production under different escapement levels. It will also provide a better means for predicting future spawning run size other than current escapement indices.

Starting May 10 or as soon after as ice conditions permit, downstream migrant trapping will commence on the Kenai River. The trap site will be located at the sonar unit installation. Downstream migrant fyke nets, with detachable cod ends will be utilized for the sampling. Lengths, weights, and scale samples will be taken to establish freshwater life characteristics of these sockeye salmon runs. The Kenai River adult-counting sonar installation will be tested for its possible application to smolt enumeration. The annual outmigration of smolts will be sampled on the Kenai River until early June when the smolt migration will be over. A preliminary investigation of smolting sites and some test fishing will also be attempted on the Kasilof River.

Part 3 of 3.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0016, SOCKEYE SALMON MIGRATORY BEHAVIOR AND BIOLOGICAL STATISTICS COLLECTION, SOUTHEASTERN ALASKA

C. ENGELKING, State Dept. of Fish & Game, *Juneau, Alaska*

Objectives: A. Delineation of migration routes. Determination of the migration routes utilized by sockeye salmon approaching their home streams has been indeterminate in Southeast Alaska for a number of years. One portion of the run will be identified by tagging in the Sumner Strait and North Clarence Strait approaches and subsequent recovery of the marked fish in (1) the commercial fishery, (2) at canneries, weirs on the spawning streams and (3) by teams of men conducting foot surveys on the spawning grounds of sockeye stream without weirs.

B. Biological Statistics Collection. The collection of biological statistics in the fishery, at canneries, weirs and in the estuarial areas at the mouths of the streams without weirs will greatly enhance the knowledge required to properly manage the sockeye salmon resource of Southeast Alaska. This will be accomplished through collection of scale and length data to assess the age classes in the fishery and in the total run; the rate of exploitation by the fishery and the timing of the various races comprising the run.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0017, PRE-EMERGENT FRY PINK SALMON FORECAST (KODIAK, ALASKA)

D.P. HENNICK, State Dept. of Fish & Game, *Juneau, Alaska*

This phase provides for the expansion and refinement of pink salmon forecast research in the Kodiak Island area. Objectives are egg and pre-emergent larva sampling of sufficient size to assure reliable forecast of the island runs and to assure a gradual accumulation of optimum escapement data in the major streams.

Essentially we are excavating random plots in important and accessible spawning streams in a manner which should give reliable year-to-year comparisons of larva survival and relative abundance. Approximately 22-25 streams are sampled annually using a standard hydraulic sampling tool. This is accomplished very near the end of freshwater life when many causes of population fluctuations have passed. With proper selection of streams about 80 percent of the escapement can be monitored.

During the early fall sampling is conducted in several selected streams for egg deposition, October through November. During the winter months analysis of data and reports are completed. In March a crew of five temporary aides are hired and arrangements are made to charter a vessel and helicopter. Preemergent sampling of 22-25 streams is conducted from March through April, usually a 6 week period. Throughout the summer and spawning period the streams to be sampled are traversed on foot and via light plane to access escapement and distribution of spawning populations and permanent markers are installed to pinpoint the location of the sampling areas.

Part 2 of 2

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0018, EXPANSION OF CURRENT AND DEVELOPMENT OF ADDITIONAL COMMERCIAL FISHERIES CATCH, PRODUCTION AND GEAR STATISTICS

B. HILL, State Dept. of Fish & Game, *Juneau, Alaska*

Objectives of the study are to (1) increase the accuracy and reliability of current state fishery statistics through the coordination of proper sampling methods, and (2) to compile and publish statistics on an area and individual fishery basis rather than on a regional or statewide basis. Procedures will consist of the following: (1) Establish uniform sampling techniques in the various areas throughout the State in order that adequate and reliable weight, number and value data can be collected. (2) Compile the catch in number and weight on a weekly or suitable time period basis for each fishery in each area of Alaska. (3) Compile the value to the fishermen of the various fisheries in each area of the State. (4) Compile effort statistics for each fishery in each area of the State. (5) Compile the volume and value of manufactured fishery products on an area basis. (6) Publish detailed annual catch, production, and effort statistics for each fishery on an area basis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5. LIVING SYSTEMS (NON-HUMAN)

5.0019, PRE-EMERGENT FRY PINK SALMON FORECAST - SOUTHEASTERN ALASKA

T.C. HOFFMAN, State Dept. of Fish & Game, *Juneau, Alaska*

The objectives of this phase of a long range pink salmon study is to compliment and extend the presently established pre-emergent fry pink salmon forecast program in Southeastern Alaska with the long range goals: (1) develop useful predictions to provide for more efficient means of harvesting existing runs, (2) to see if the same sampling methods can be utilized with chum salmon.

Previous sampling activities, because of access problems, have been primarily located in intertidal and adjacent spawning areas. Distribution of sampling effort is made randomly within the total area included in a base stratum. This yields fry abundance from sixty plus streams in Southeastern Alaska which is projected statistically to the total area of the base stratum.

Fry production information for areas considerably removed from tidal influence especially in very large streams is an unknown factor and the primary emphasis of this phase is to fill that knowledge gap.

Fry production estimates will be made in upstream areas of twenty formerly inaccessible streams in Southeastern Alaska. These estimates will be integrated with the existing program in attempting to arrive at an estimate of returning pink salmon runs.

Sampling will be conducted with a hydraulic pump and the procedures are essentially as described in McNeil, William J. 1962. Mortality of pink and chum salmon eggs and larvae in Southeast Alaska streams.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0020, POPULATION STUDIES OF ANADROMOUS FISH - UPPER COOK INLET DRAINAGES

S.W. KUBIK, State Dept. of Fish & Game, *Juneau, Alaska*

Objectives: (1) To determine the sport fish catch of king salmon and evaluate angling pressure in the selected freshwater areas of Upper Cook Inlet. (2) To determine the distribution, abundance, time of arrival, age, size classes, sex ratios and spawning areas of adult king salmon and silver salmon in the various sterams of Upper Cook Inlet. (3) To investigate Ship Creek and associated areas on Upper Cook Inlet as a source for the procurement of king salmon eggs for experimental hatching and rearing. (4) To evaluate the contribution of artificial ponds to the stocks of anadromous fishes to Ship Creek. (5) To conduct silver salmon harvest studies in selected tributaries of the Susitna River Drainage.

Procedures: (1) Creel census efforts will be directed towards obtaining information on numbers of king salmon caught, angling effort, lengths, weights, and sex of an adequate sample of fish caught. Scale samples will be collected for age analysis as appropriate. Data obtained from the return of the special king salmon punch cards will be evaluated in terms of total harvest, individual stream harvest, and angler success and participation

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Alaska State Government

5.0021, IDENTIFICATION OF RED SALMON STOCKS TAKEN IN THE CAPE KUMLIK-ANIAKCHAK BAY FISHERY (CHIGNIK AREA)

J. LECHNER, State Dept. of Fish & Game, *Juneau, Alaska*

A red salmon Cape fishery has developed at Cape Kumlik on the south side of the Alaska Peninsula, since 1960. This study will determine the origin of these red salmon stocks, so that an established management basis may be determined for this Cape fishery. Indications from a limited tagging study in 1963, suggests that these stocks are bound for the Chignik River red salmon system, which is presently closely managed for obtainment of desired escapement goals. A building return of red salmon has escaped into the Aniakchak system, which must be evaluated for the degree of contribution to the building Cape fishery. The location of the work will require tagging of red salmon at the Cape Kumlik fishery with Pedersen type disc tags, which will be in number sequence and the recovery of these tags by method of tag reward from the commercial fishery and spawning ground tag recovery from the two major red systems within the area. Red salmon scales will be taken for morphological differentiation, from the Cape fishery and the major red salmon's systems within the area. A temporary field camp will be established for the Aniachak spawning ground survey. One Fisheries Biologist IV, one Fisheries Biologist I, and six temporary Fish and Game Aides will conduct the study.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0022, BRISTOL BAY INTERMEDIATE HIGH SEAS-INSHORE TEST FISHING

K.R. MIDDLETON, State Dept. of Fish & Game, *Juneau, Alaska*

A) OBJECTIVES - 1) To provide annual forecasts of the magnitude and age composition of the Bristol Bay sockeye runs after the runs have been exposed to the high seas fishery and just prior to the time they reach the inshore fishery. These forecasts will be used in conjunction with the existing high seas and inshore forecasts. 2) To obtain information regarding the annual timing and pattern of entry of the Bristol Bay sockeye into Bristol Bay.

B) PROCEDURES - 1) A large fishing vessel equipped with sonar fish-finding equipment will be used to fish standard 5-3/8' stretch measure gillnet north of Port Moller during the period 6/10-7/10 to obtain an index of abundance of red salmon migrating to Bristol Bay. The basic procedures will be designed after existing high seas procedures. 2) Fish captured will be sampled for age-weight-length data to provide an estimate of the age composition of the returning run. This will provide a second check on previous forecasts which provide estimates of return by age class. Differentiation of the stocks according to river system may also be possible on the basis of scale characteristics. 3) Information will be radioed daily to the King Salmon management office to aid in the management of the returns.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0023, BRISTOL BAY OFFSHORE TEST FISHING PROGRAM

K.R. MIDDLETON, State Dept. of Fish & Game, *Juneau, Alaska*

The objective of this program is to annually monitor the Bristol Bay adult sockeye run as it passes north of Port Moller enroute to Bristol Bay in an attempt to estimate the magnitude, age composition and pattern of entry.

Test fishing will be conducted nightly with 5-3/8' gill net as utilized by the Bristol Bay inshore commercial fishery. Approximately five test drifts will be made nightly at different stations along a 50-mile northerly transect originating at Port Moller. The data from the five drifts will be combined to obtain a nightly index of fishing success. Fish captured will be sampled for age composition.

Test fishing on the 1967 sockeye run will be completed during the period July 1-10, 1967. During the period July 10 to June 30, 1968, reports will be completed on the 1967 season. Sampling plans will be revised if necessary for the 1968 season. Test fishing on the 1968 run will be conducted during the period June 10-30, 1968.

In addition to the five-man crew for the charter fishing vessel, two biological aides will be aboard the fishing vessel during the test fishing period.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0024, ARCTIC-YUKON-KUSKOKWIM AREA ANADROMOUS FISH INVESTIGATIONS

R.I. REGNART, State Dept. of Fish & Game, *Juneau, Alaska*

Salmon research studies in this area prior to 1961 are almost non-existent. Recent studies by the Alaska Department of Fish and Game have been encouraging but accurate estimations of the sizes of runs and escapements have yet to be determined. Also much basic life history information is still lacking for some species of salmon.

The long range objectives of this project are to determine the population sizes and escapements, destination and timing of different segments or races and life histories of Arctic-Yukon-Kuskokwim area salmon runs. Procedures will consist of the following: (1) gill nets will be operated for the capture of salmon which will be tagged and released. Cash reward for recoveries will be offered. (2) Commercial- subsistence catches and carcasses from several 'key' tributaries will be sampled periodically. (3) Aerial surveys and boat or ground surveys will be made of 'key' tributaries in order to determine escapements.

Sheefish - The sheefish or inconnu, Stenodus leuchichthys is a member of the whitefish family and is abundant in northwestern Alaska, e.g. Kuskokwim, Yukon and Kotzebue Sound drainages. Recently there have been numerous requests on the part of area residents and interested processors relative to the feasibility of establishing commercial fisheries for sheefish. The habits, life histories and productivity of sheefish are virtually unknown. The objectives of this phase of the project are to acquire the necessary population dynamics, life history and other pertinent information needed to determine the feasibility of developing a sheefish commercial fishery. Procedures are to include the following: (1) research of existing literature and interview of fishermen, buyers, pilots, etc., (2) operate various types of fishing gear on a year-round basis, (3) tag and release sheefish in selected areas and offer rewards for tag recoveries. (4) conduct surveys of subsistence fisheries by distribution of catch calendars and actual counts and, (5) sample test net and subsistence-commercial catches for age, size, sex and fecundity information.

Subsistence fishery - Subsistence utilization of salmon and sheefish will be documented by personal interviews, direct counts, and catch questionnaires from August through September.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0025, COPPER RIVER SOCKEYE SALMON INVESTIGATIONS

R.S. ROYS, **State Dept. of Fish & Game, *Juneau, Alaska***

A. OBJECTIVES: 1) To determine the qualitative and quantitative Copper River sockeye salmon escapement immediately following exploitation by the commercial gill net fishery and on the upstream migration.

B. LOCATION: Copper River and its tributaries of Southcentral Alaska. Base of operations - Glennallen and Cordova.

C. PROCEDURES: 1) Delta Investigations a. Test fishing will be employed as an immediate index of escapement. Four chartered gill net boats utilizing standard gear will fish during closed fishing periods. Relative abundance per time of set, timing of runs, and migration patterns will be obtained. b. Scales for age determination and other biological statistics will be obtained by sampling the canneries and from the test fishing operations.

2) UPPER RIVER INVESTIGATIONS - a. Tagging will be employed to separate the different stocks of fish. Fishwheels at Woods Canyon will be used in a cooperative effort with the River Basins Branch, BCF, tagged to untagged ratios will be investigated as a means of obtaining a population estimate of the run. b. Biological statistics will be collected for stock identification and separation at the tagging and recovery sites and surveys of the spawning escapement will be made. c. Possible selectivity of the gill net fishery will be investigated by comparing upriver and delta lengths and possible sites for electronic counters will be conducted.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0026, COPPER RIVER SOCKEYE SALMON INVESTIGATIONS

R.S. ROYS, **State Dept. of Fish & Game, *Juneau, Alaska***

Objectives: 1. To determine the qualitative and quantitative Copper River sockeye salmon escapement immediately following exploitation by the commercial gill net fishery and on the upstream migration.

Procedures: 1. Delta Investigations: (a) Test fishing will be employed as an immediate index of escapement. Four chartered gill net boats utilizing standard gear will fish during closed fishing periods. Relative abundance per time of set, timing of runs, and migration patterns will be obtained. (b) Scales for age determination and other biological statistics will be obtained by sampling the canneries and from the test fishing operations. (2) Upper River Investigations: a. Tagging will be employed to separate the different stocks of fish. Fishwheels at Woods Canyon will be used in cooperative effort with the River Basins Branch, BCT. Tagged to untagged ratios will be investigated as a means of obtaining a population estimate of the run. (b) Biological statistics will be collected for stock indentification and separation at the tagging and recovery sites and surveys of the spawning escapement will be made (c) Possible selectivity of the gill net fishery will be investigated by comparing upriver and delta lengths and possible sites for electronic counters will be conducted.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0027, SOCKEYE SALMON MIGRATORY BEHAVIOR AND BIOLOGICAL STATISTICS COLLECTION, SOUTHEASTERN ALASKA

UNKNOWN, **State Dept. of Fish & Game, *Juneau, Alaska***

Objectives: A. Delineation of Migration Routes: Determination of the migration routes utilized by sockeye salmon approaching their home streams has been indeterminate in Southeast Alaska for a number of years. One portion of the run will be identified by tagging in the Sumner Strait and North Clarence Strait approaches and subsequent recovery of the marked fish in (1) the commercial fishery, (2) at weirs on the spawning streams and (3) by teams of men conducting foot surveys on the spawning grounds of sockeye streams without weirs. B. Biological Statistics Collection: The collection of biological statistics in the fishery, at the weirs and in the estuarial areas at the mouths of streams without weirs will greatly enhance the knowledge required to properly manage the sockeye salmon resource of Southeast Alaska. This will be accomplished through collection of scale and length data to asses the age classes in the fishery and in the total run; the rate of exploitation by the fishery and the timing of the various races comprising the run.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0028, OFFSHORE SALMON ABUNDANCE INDEX

UNKNOWN, **State Dept. of Fish & Game, *Juneau, Alaska***

Objectives: A. To establish an index of abundance of salmon (primarily pink salmon) in the immediate offshore waters of Southeastern Alaska prior to the appearance of the runs in the commercial fisheries. B. Stock identification and timing as the runs approach the coast, the fishery and their home streams.

Procedures: Gill nets and long line gear will be fished on a predetermined schedule. All viable salmon will be tagged and released after a scale and length measurement are taken.

Tag recovery will be effected in the commercial fishery, at weirs on streams and by foot survey crews on the salmon streams.

The area to be fished is a 50 mile band off the coast of Southeastern Alaska from Yakutat to Dixon Entrance from approximately June 1 to July 31.

The program is designed to operate a minimum of five years. All data collected will be processed by electronic data processing methods and will be available for correlation with previous and current programs of the United States and Canada in this area of work.

Personnel will involve two temporary biological aides on each vessel and a permanent biologist in charge of the program.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0029, FISH POPULATIONS IN THE CHENA RIVER

F. VANHULLE, **State Dept. of Fish & Game, *Juneau, Alaska***

5. LIVING SYSTEMS (NON-HUMAN)

Objectives: (1) Become familiar with the Chena River watershed and test various methods of sampling the fish populations. (2) Establish techniques for determining the following population dynamics of the fish in the Chena River: a) Species composition. b) Age and sex composition of grayling, pike and whitefish. c) Trends and extent of natural movements. d) Spawning locations. (3) Determine the present utilization of the recreational fishery on the Chena River.

Procedures: (1) Initial investigations will be directed toward becoming familiarized with the Chena River watershed. The river will be arbitrarily sectioned off to provide a number of basic reference points for the different aspects of the study program. Fish will be collected from the Chena River by those means which are deemed most efficient at the time. (2) In conjunction with Objective (2), the following procedures will be followed: a) Location and time of capture will be noted for all fish taken. Fish released will be marked; in addition all grayling and pike over 6 inches will be tagged. b) Scale samples, length and weights will be taken of all tagged fish. In addition, random samples of grayling, pike and whitefish will be sacrificed for sex identification. c) Periodic surveys and sampling will be conducted throughout the year to determine, as far as possible, the movements of the fish within the river system. Investigations will be conducted to determine possible overwintering areas and their utilization by the various fish populations. d) An extensive stream survey will be initiated. Basic chemical and physical data will be collected with special emphasis placed on the location of active and potential spawning areas. (3) Periodic fishermen interviews will be conducted on the Chena River. Aerial and ground counts of the number and location of fishermen will be made to determine present utilization of the sport fishery.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Alaska State Government

5.0030, BOTTOMFISH EXPLORATIONS

B.F. JONES, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Juneau, Alaska* 99801

Bottomfish exploration is primarily concerned with benthic vertebrate populations. The objectives are to define, on a seasonal basis, the quantitative and qualitative distribution of aquatic benthic vertebrate resources having a potential for comerical utilization, and to provide an appraisal of those resources. In its full extent, bottomfish exploration is a cataloging of benthic vertebrate fauna in time and space.

Area stressed is the Northeastern Pacific primarily the Gulf of Alaska and Bering Sea. The explorations are carried out by the Juneau- based vessel John R. Manning and chartered vessels.

Sampling has been conducted along the Continental Shelf with a standard commercial otter trawl. New trawling grounds and new commericial concentrations of bottomfish have been discovered. Sampling will be continued on the continental slope and a reevaluation of the shelf with different types of fishing gear including pelagic trawls will be done. Biological observations will be made.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0031, TECHNICAL ASSISTANCE TO INDUSTRY

B.F. JONES, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Juneau, Alaska* 99801

This program is structured to provide the services and skills of a specialist (or specialists) in the field of commercial fishing to serve as a consultant, advisor, and instructor to fishermen and processors. The staff also provides similar services to other disciplines of the Bureau of Commercial Fisheries in this region - including biological, oceanographic and technological research. The project leader acts as liaison between the Bureau and segments of the commercial fishing industry as the need arises. In specific situations, and under proper control, assistance may be provided in the form of loaned fishing gear and equipment to permit individuals or processors to pursue new methods or developments in potential or established fisheries.

Objectives: To furnish the fishing community with current information relative to new developments in their industry and provide assistance in the development and/or introduction of new fisheries to specific areas of Alaska.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0032, FISH POPULATION OFF THE ISLAND OF TUTUILA, AMERICAN SAMOA

J.R. HOLLOWAY, Amer. Somoa Dept. of Agric., *Pago Pago - Tutuila, American Samoa*

Objectives: Locate banks and fish concentrations as well as determine availability and abundance of bait species. Collect specimens for taxonomic study and identification of potentially commercially valuable species.

Procedures: Scout for fish concentrations and banks areas using small skiff and Furuno gear. Collect specimens by handlines and trolling. Survey accessible in-shore areas for bait species.

Location of Work: Around Island of Tutuila, American Samoa.

Part 2 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
American Samoa Government

5.0033, FISH POPULATIONS OF AMERICAN SAMOA

J.R. HOLLOWAY, Amer. Somoa Dept. of Agric., *Pago Pago - Tutuila, American Samoa*

Objectives - Intensely fish banks and areas of fish concentration located in Phase I and other potential areas not within range of the skiff. Determine numbers and kinds of potentially valuable fish and shell fish, and maintain records of seasonal and areal variation.

Procedures - With a small sampan from Hawaii, use various gear including handlines, traps, lobster pots, seines and trolling gear to determine species available and abundance. Records will be kept of date of catch, total catch, gear and personnel used, special conditions noted and other factors likely to be important in the intelligent utilization of off-shore stocks or marine fish and shellfish species.

Work Schedule - Initial period - from approximately February 1, 1967 to June 30, 1967. Phase to be extended for at least 1 year for accurate records of seasonal and areal variation in abundance.

Part 3 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
American Samoa Government

5.0034, TAXONOMIC STUDIES

E.S. HOBSON, U.S. Dept. of Interior, Tiburon Marine Lab., *Belvedere - Tiburon, California* 94920

Taxonomic studies (a continuous program considering material incidently becoming available in the course of the other projects). a. Revision of the family Scaridae in the eastern Pacific. b. Revision of the family Labridae in the eastern Pacific.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0035, LIFE HISTORY OF CLUPEA HARENGUS PALLASI

G.B. TALBOT, U.S. Dept. of Interior, Tiburon Marine Lab., *Belvedere - Tiburon, California* 94920

Experiments will be undertaken to artificially fertilize the eggs of Pacific herring (Clupea harengus pallasi) and to raise them in captivity. When competence is developed in this procedure, experiments with these fish will be carried out to determine the effects of varying temperatures and salinities on their meristic characters.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0036, TAGGING PROGRAM WITH WOODS HOLE AND INTERNATIONAL GAME FISH ASSOCIATION FOR MARLIN, SAILFISH AND OTHER GAME SPECIES MIGRATION STUDIES

G.B. TALBOT, U.S. Dept. of Interior, Tiburon Marine Lab., *Belvedere - Tiburon, California* 94920

Objective -- To determine the population distribution and amount of inter-migration between oceanic areas for many of the marine game species.

Procedure - Develop a cooperative sportsman tagging program by encouraging participation by active sportsmen. Tagging and record deeping equipment shall be furnished, and records of all Pacific area game fish tagging shall be maintained by the Tiburon Marine Laboratory. Analyses will be made of tagging recoveries for species currently under study (marlin and sailfish). Program expected to be expanded to include sharks and other pelagic and demersal marine game species common to the eastern Pacific.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0037, SPECIES LIFE HISTORY AND DISTRIBUTION

E.H. AHLSTROM, U.S. Dept. of Interior, Fishery Oceanography Ctr., *La Jolla, California*

This program deals with the identification, geographic distribution, and estimates of abundance of the younger stages of fishes--eggs, larvae, metamorphosing specimens, and juveniles--which are collected in quantitative plankton hauls. The area of principal concern is the California Current region off California and Baja California, but pelagic fish larvae are being studied from all parts of the eastern Pacific, including the eastern tropical Pacific (EASTROPAC cruises). We are concerned with descriptions of the younger stages of pelagic fishes and their zoogeographic distributions as related to water masses. We have developed the use of systematic surveys of ichthyoplankton as a fundamental means of assessing our pelagic fish resources. The ultimate objective is the description of the developmental stages of all common pelagic fishes in the eastern North Pacific.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0038, SCHOOLING BEHAVIOR

J.R. HUNTER, U.S. Dept. of Interior, Fishery Oceanography Ctr., *La Jolla, California*

The purpose of this project is to obtain information on the internal structure of adult fish schools (anchovy, sardine, mackerels, etc.) important to the commercial fisheries of California. Research underway concerns study, under varying environmental and physiological conditions, of the manner in which fish react to one another, thereby altering the structure of the school. This work is based on experiments performed in large holding tanks and various experimental containers in the laboratory ashore.

In order to test whether these experimental models of fish school structure and behavior are applicable to fish under natural conditions, it is planned to observe the behavior of wild schools of the same species of fish at sea by aerial and underwater photography. Extensions of this same project will include investigations of the manner in which the adult schooling behavior patterns are developed during the larval stages of the same species and motor system development in larvae.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0039, FISH POPULATION PARAMETERS

J.S. MACGREGOR, U.S. Dept. of Interior, Fishery Oceanography Ctr., *La Jolla, California*

A knowledge of the life histories of the various fish populations is necessary in order to understand the population dynamics of marine fish stocks. It is especially important to discover which factors are critical in determining year-class size. The purpose of this project is to describe the spawning cycle of the northern anchovy, of various rockfish, and of saury and to compare and contrast fish spawning patterns in time and space. These data in conjunction with estimates of stock abundance from egg and larval surveys will be used to inventory species biomass in the California Current.

Related work in this project includes a continuing analysis of the age and length composition of the anchovy population in cooperation with the California Department of Fish and Game, and the monitoring of the Ensenada wetfish landings to supplement information gathered by the State from the commercial landings of this species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0040, FEEDING BEHAVIOR

C.P. OCONNELL, U.S. Dept. of Interior, Fishery Oceanography Ctr., *La Jolla, California*

The ingestion of food by an individual fish is the climax of a complicated and plastic behavior pattern. This project is planned to describe this behavior pattern, particularly for the northern anchovy and Pacific sardine, and to determine the effects of environmental and physiological variables on the nature of the feeding pattern.

Work in progress includes observation and experimentation upon captive schools of adults in the laboratory which will later be extended to larval and juvenile forms, and a study of the sensory mechanisms upon which the feeding behavior pattern is based in these species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0041, REARING MARINE FISH

G.O. SCHUMANN, U.S. Dept. of Interior, Fishery Oceanography Ctr., *La Jolla, California*

This project has as its primary goal the development of techniques to hold larval fish throughout their development in a healthy, normal condition under controlled conditions of temperature, light, food, etc. in experimental containers. Because of the excellent experimental aquarium facilities now available in the Fishery-Oceanography Center, more than 30 species of marine fish, including the sardine, anchovy, and Pacific mackerel, have been successfully reared by empirical methods, from the egg through the juvenile stage. When these techniques are standardized and quantified, it is planned to measure the effect of environmental variables on feeding, growth, survival and morphology of larval fish by experimental work in the laboratory.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0042, SUBPOPULATIONS

A.M. VROOMAN, U.S. Dept. of Interior, Fishery Oceanography Ctr., *La Jolla, California*

The purpose of this project is to study the subpopulation structure of commercially important fish species, i.e., to determine if a species is made up of a single homogenous population or of several, genetically distinct subpopulations, each of which may have different characteristics of growth, mortality, longevity, fecundity, migration, and availability. Initial attention was centered on the Pacific sardine and three subpopulations have been recognized in this species by the frequency of occurrence of the C-positive antigen in the red blood cell.

Similar methods of analyzing genotypes are now being applied to the northern anchovy, Pacific hake, and Pacific mackerel. The study of each species may be divided into three parts: 1) the development of methods to identify subpopulations such as immunological techniques, 2) delimiting the geographical range of each subpopulation, and 3) supply data to determine the contribution of each subpopulation to the commercial catch.

When techniques have been worked out which will permit satisfactory shipment to laboratories in Japan and Oceania, a study will also be undertaken on the albacore which has been tracked across the Pacific.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0043, DISTRIBUTION OF THE MID-WATER FISHES OF THE GULF OF CALIFORNIA

B.H. ROBISON, Stanford University, Graduate School, *Palo Alto — Stanford, California* 94305

The study is being based on collections made in the Gulf of California by the research vessel TE VEGA during its Cruise number 16, September 15, 1967 to December 1, 1967.

Sampling gear consisted of a Tucker Trawl with an opening-closing device, a depth recorder and an attached meter net. Collections were made from Latitude 29 degrees 59' N. to Latitude 22 degrees 42' N. in the Gulf. Seventy collection stations resulting in the capture of over 10,000 fish were made.

Hydrographic stations were made adjacent to the trawling sites where environmental parameters such as temperature, salinity, oxygen concentration, and water mass structure were measured.

At the Hopkins Marine Station, the fishes are to be identified and the collection data coordinated with environmental factors to provide an outline of distribution. Vertical distribution relative to light and the deep scattering layer is also being studied.

SUPPORTED BY U.S. National Science Foundation

5.0044, FOOD HABITS STUDY OF ORGANISMS OF THE CALIFORNIA CURRENT SYSTEM

P.M. ROEDEL, State Dept. of Fish & Game, *Terminal Island, California*

Objectives: To determine the food habits and requirements of as many of the significant fishes and cephalopods inhabiting the California Current System adjacent to California as can be accomplished.

Procedures: Stomachs of such economically important and potentially important organisms as hake, bonito, rockfish, albacore, jack mackerel, salmon, yellowtail, barracuda, squid, etc., will be systematically collected throughout their range and the contained food items will be identified to species, their number determined per stomach, and their original sizes determined from such component parts as can be found (fish otoliths, cephalopod beaks, crustacean legs, etc.). Sampling will take advantage of departmental investigation, both routine and exploratory, programs of other agencies and institutions, and commercial and sport fishing at ports and places of landing.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
California State Government

5.0045, SPORT FISH BEHAVIORAL STUDIES

C.H. TURNER, State Dept. of Fish & Game, *Terminal Island, California*

Objective: To further our knowledge of sport fish behavior in rocky subtidal areas with particular emphasis being placed on sculpin (Scorpaena guttata), kelp, sand, and spotted sand bass (Paralabrax clathratus, P. nebulifer, and P. maculato-fasciatus, and sheephead (Pimelometopon pulchrum).

Procedures: At every opportunity, diving observations will be made, photographs taken and analyzed, and fish movements studied. In addition, an average of 2 days per month is scheduled for behavioral studies in promising areas where feeding, breeding, defensive schooling, and other aspects of social life can be observed and documented. Study emphasis is being placed on the five species listed because they are known to be important 'reef-dependent' fishes (Turner, Ebert, and Given, Artificial Reef Ecology, unpublished ms; Carlisle, Turner, and Ebert, Calif. Fish and Game Fish Bull. 124; and Turner, Ebert, and Given, Calif. Fish and Game Fish Bull. 140, in press) which are actively sought by sportsmen, and because additional life history and behavior information is needed to permit their more effective management.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
California State Government

5.0046, A STUDY OF THE RATE AND PATTERN OF SHAD MIGRATION IN THE CONNECTICUT RIVER UTILIZING SONIC TRACKING APPARATUS

W.C. LEGGETT, Essex Marine Laboratory Inc. , *Essex, Connecticut*

Objectives: To investigate rate of movement of American shad from the mouth of the Connecticut River upstream to include movement through the area of heated effluent outfall of an atomic power plant before operation and through non-channeled and major spawning area of the river.

Procedures: Shad, taken with monofilament gill nets and/or beach seine will be tagged with sonic tags and tracked as individuals and/or loose schools through the above areas of the river. Tagged shad will be held in live cars to check tag operation and delayed handling mortality. Hand held and boat mounted hydrophone receivers will be utilized to track shad as long as possible. Daily trips will be made to locate tagged fish. Data will be processed automatically and compared with other available tagging data.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Connecticut State Government

5.0047, SHARK RESEARCH

J. OLIVE, Amer. Inst. of Biolog. Sci. , *Washington, District of Columbia* (NONR)

Under this work unit, the Shark Research Panel, the International Shark Tagging Program, and other coordinating activities in relation to shark studies are supported. These activities include a determination of the seasonal and geographic distribution of all species of sharks on a world-wide basis and guidance for a scientific campaign of research and education regarding shark and shark repellents and a cooperative effort toward these goals with similar efforts in other countries.

This is part of the Noxious Marine Animals Program and is concerned specifically with the biology of sharks. These primitive fishes have adapted with great success to life in the sea and have evolved a wide variety of physiological and behavioral responses to marine environmental factors. These facts make the sharks a particularly difficult animal to control. They represent a physical, as well as a psychological, hazard to personnel operating in the water and to survivors of plane or ship disasters. The search for an effective control or repellent must be based on accurate information regarding their diverse habits and their distribution.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0048, STUDIES ON ANACANTHINE FISHES

D.M. COHEN, Smithsonian Institution, *Washington, District of Columbia* 20560

Much work remains to be done on the taxonomy of anacanthine (cod- like) fishes. Some projects under way are: (1) A monograph on Anacanthini (exclusive of Macrouridae) of the western North Atlantic. (2) A taxonomic revision of the family Moridae (mostly fishes of the continental shelves and slopes).

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0049, SYSTEMATICS AND BIOLOGY OF EPIPELAGIC AND BATHYPELAGIC FISHES

R.H. GIBBS, Smithsonian Institution, *Washington, District of Columbia* 20560

Studies on the systematics and biology of epipelagic and bathypelagic fishes will comprise the followint units: systematics of Scombroidei, copepod parasites as indicators of scombroid phylogeny, zoogeography of the midwater fishes of the western Indian Ocean, ecological analysis of epipelagic fishes in the western North Atlantic, ecological analysis of the midwater fishes of a single water column in the western North Atlantic, systematics and biology of Atlantic flyingfishes, systematics of the Lancetfishes, and anatomy and histology of gonads as indicators of relationships in deep sea fishes.

SUPPORTED BY Smithsonian Institution

5.0050, SYSTEMATIC REVISION PLATYCEPHALIDAE (PISCES)

L.W. KNAPP, Smithsonian Institution, *Washington, District of Columbia* 20560

The systematics of the Indo-Pacific fishes of the family Platycephalidae are poorly understood. This benthic group includes approximately 115 nominal forms, a number of which have some importance as food. Several species have been reported to be protandrous hermaphrodites but others appear to be gonochoristic.

Results of several recent regional studies indicate the need for a comprehensive family revision to untangle existing problems in nomenclature and phylogeny. A moderate amount of material for such a revision is available in this country. Specimens from the International Indian Ocean Expedition are currently under study and material at various U. S. museums will be examined during fiscal years 1969 and 1970.

As the majority of the types and a considerable amount of additional material must be studied in several European museums, a two-month trip for this purpose is planned for fiscal year 1971. Other important holdings of types and additional material are located in several Australian museums and a trip to these institutions is planned during fiscal year 1972.

SUPPORTED BY Smithsonian Institution

5.0051, SYSTEMATICS AND ZOOGEOGRAPHY OF THE BLENNIOID FISHES
V.G. SPRINGER, Smithsonian Institution, *Washington, District of Columbia* 20560

The ultimate purposes of this project are: the completion of systematic revisions of all the members of the superfamily Blenniicae with emphasis on variation, distribution, and relationships; the determination of the nature of the extra-superfamilial relationships; and the application of the derived results towards an understanding of the percoid fishes in general. Present studies center on the osteology of the Blenniidae and a revision of the genus Atrosalarias.

SUPPORTED BY Smithsonian Institution

5.0052, STUDIES OF FISH FAMILIES ARIIDAE AND ASPREDINIDAE
W.R. TAYLOR, Smithsonian Institution, *Washington, District of Columbia* 20560

To study the systematics, relationships, and zoogeography of the tropical marine catfish family Ariidae and the South American marine species of Aspredinidae.

SUPPORTED BY Smithsonian Institution

5.0053, OSTEOLOGY AND EVOLUTION OF ISOSPONDYLOUS AND OSTARIOPHYSAN FISHES
S.H. WEITZMAN, Smithsonian Institution, *Washington, District of Columbia* 20560

This project consists of several smaller research efforts all contributing to the understanding of the morphology and evolution of recent, relatively primitive teleost fishes.

SUPPORTED BY Smithsonian Institution

5.0054, STUDIES ON OPHIDIOID FISHES
D.M. COHEN, U.S. Dept. of Interior, Systematics Laboratory, *Washington, District of Columbia* 20560

There are perhaps 500 species of this group. Problems are: (1) Definition and relationships of Ophidioidea. (2) Families of Ophidioidea. (3) Anatomical studies which will allow definition of genera. (4) Description of species. (5) Studies on depth and areal distribution.

This group is an important part of the abyssal benthic fauna, and studies on general biology of abyssal fishes will be made as appropriate.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0055, TAXONOMIC REVISION OF BATHYLAGIDAE
D.M. COHEN, U.S. Dept. of Interior, Systematics Laboratory, *Washington, District of Columbia* 20560

Taxonomic revision of the oceanic fish family Bathylagidae. These are small midwater fishes found in all major temperate and tropical oceans. About 20 species have been described. Keys, illustrations, description and distribution charts will be prepared.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0056, SYSTEMATIC STUDIES ON THE FAMILY SCOMBRIDAE
B.B. COLLETTE, U.S. Dept. of Interior, Systematics Laboratory, *Washington, District of Columbia* 20560

The family Scombridae is comprised of some 40-45 species of medium to large-sized fishes found in all the oceans. Many are of great commercial importance. The classification, both at the generic level and the species level, is confused in spite of the large amount of time and money that has been spent trying to solve the problems in the group. The search for characters useful in defining taxa within the family has lead to the use of internal characters such as the osteology, circulatory system, and position of the viscera. This project is a long-term study that will redefine all the genera and species and provide keys for identification, figures, distribution maps, and summaries of the biology. A preliminary review of the family, an illustrated key to the species of the Indian Ocean, and anatomical and systematic revision of the great tunas, genus Thunnus have been published. Studies of Euthynnus, Katsuwonus, and Allothunnus are under way. Skeletal material of all forms is being accumulated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0057, DESCRIPTIONS OF NEW SHARKS
S. SPRINGER, U.S. Dept. of Interior, Systematics Laboratory, *Washington, District of Columbia* 20560

Collections of sharks made by research vessels over the past few years are being studied. These appear to contain at least 10 new species which will be described for publication. Continuing.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0058, A REVISION OF THE CAT SHARKS, SCYLIORHINIDAE
S. SPRINGER, U.S. Dept. of Interior, Systematics Laboratory, *Washington, District of Columbia* 20560

The work to redefine the family Scyliorhinidae, its genera, and the 50 to 60 included species. The last general revision (1908) and a partial revision (1948) were brief and were based on examinations of small numbers of specimens with attention to only a few morphological details.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0059, SYSTEMATIC STUDIES OF FISHES
F.H. BERRY, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab., *Miami, Florida*

Objectives: To improve upon our knowledge of the taxonomy of the orders, families, genera, and species of marine fishes, principally those of the Atlantic Ocean. To facilitate the ready identification of these fishes, especially those of commercial or potentially commercial importance. To determine data on the morphology and ontogeny of these fishes that will assist in early development and in life history studies. In the study of selected fish groups, to develop principles of morphology and ontogeny that will relate to the resolution of knowledge of other similar but unstudied groups.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0060, TAXONOMY AND BIOLOGY OF CLUPEOID FISHES
F.H. BERRY, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab., *Miami, Florida*

To discriminate between the various species of Clupeidae and Engraulidae, especially those of tropical and subtropical marine waters, with emphasis on the Atlantic Ocean. To do this by study of their comparative morphology, and to a lesser degree with biochemical, behavioral, and certain life history studies. To prepare a field guide of these species that will facilitate their identification by ichthyologists, fishery biologists, and fishermen.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0061, SYSTEMATICS OF CARANGID FISHES
F.H. BERRY, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab., *Miami, Florida*

To obtain additional specimens of carangid fishes and appropriate field data to allow resolution of the taxonomic problems concerned. To prepare scientific accounts in the field guides that will define the various species and growth stages.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5. LIVING SYSTEMS (NON-HUMAN)

5.0062, BEHAVIOR OF LARVAL FISHES

W.J. RICHARDS, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab. , *Miami, Florida*

Objectives: 1. To rear fish larvae for confirmation of identification. 2. To study the growth, feeding habits, and tolerance of the larvae to temperature, salinity, oxygen, light and other environmental variables. 3. To study the general ethology of larvae and, in particular, their behavior in relation to thermal stratification and other simulated environmental barriers. 4. To study the feasibility of rearing fishes from the eggs on a commercial basis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0063, DISTRIBUTION AND ECOLOGY OF ATLANTIC TUNAS

J.P. WISE, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab. , *Miami, Florida*

Objectives: To determine the effect of environmental parameters on the geographical and temporal distribution of Atlantic tunas in sufficient detail to be able to predict such distributions from knowledge of the environment so as to increase the efficiency of fishing effort.

Fishery-oceanography surveys of the tropical Atlantic have been and will continue to be carried out by research vessels of this laboratory. Such surveys will yield data that will allow comparison in space and in time of the ecology and life history, as well as the population dynamics of the tunas in the areas surveyed.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0064, MIGRATION OF ATLANTIC TUNAS

J.P. WISE, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab. , *Miami, Florida*

We have made explorations into the possibilities of initiating a tagging program in cooperation with ORSTOM, and other West African activities. Operations probably will start in the West African tuna fishery. A staff member has investigated the possibilities of such an arrangement during a trip to African tuna ports. Present thinking lies along the lines that the BCF (TABL) coordinate and finance most of such a cooperative program, and that the other participating agencies provide the majority of the field personnel.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0065, POPULATION DYNAMICS OF ATLANTIC TUNAS

J.P. WISE, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab. , *Miami, Florida*

The most essential need is for a reliable estimate of the magnitude of the fishery, i.e., the total catch and landings.

Second in importance is to obtain reliable figures on the catch- per-unit effort involved for at least representative portions of the fishing fleets, in order to estimate relative abundance and changes in abundance of the fishable stocks.

Third is the biological sampling of the fishery--collection of data on length, weight, state of gonad development, stomach contents, etc., from the landed fish. Some of this information also is essential to other projects within this program.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0066, ICHTHYOFAUNA OF THE FLORIDA CURRENT

C.R. ROBINS, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

The studies are on the fish faunas of the Florida current have emphasized seasonal and depth distribution and ecological parameters otherwise influencing numbers and abundance. Sampling of the fishes and photographs of the sea bottom has enabled many distribution abundance questions to be answered. The overall aim is to identify the populations of fishes at all depths and latitudes in the Florida Current area, and to determine what ecological factors are responsible for differences in numbers and distribution.

SUPPORTED BY U.S. National Science Foundation

5.0067, SHORE FISHES OF ANNOBON AND FERNANDO POO

C.R. ROBINS, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

Objective: To study comprehensively the collections of shore fishes collected at 18 stations at Fernando Poo and Annobon and to report on them in a series of short papers plus a comprehensive terminal report. The study will emphasize description and characterization and will not attempt (as part of this effort) to fill the more long term need for detailed comparisons of transatlantic populations, etc.

Drawings will be made for the new species or for those previously unfigured or poorly illustrated. In some instances photographs will suffice, but in most, particularly the smaller forms, drawings are desirable.

The collections are now in alcohol but they must be sorted and processed. Most material ultimately will be deposited in either the National Museum, the Academy of Natural Science, or in both.

SUPPORTED BY U.S. National Science Foundation

5.0068, OCEANIC FISHES OF THE TROPICAL ATLANTIC

C.R. ROBINS, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

This investigation is for the continuation of the research initiated under GB-1350 and GB-4389 for long-range exploration of the oceanic fish fauna of the tropical Atlantic.

The ichthyological program of the Institute of Marine Science has aimed since its inception at the delineation of the fish fauna of the Tropical Atlantic and at understanding the various community structures. Two aspects have been considered at the same time. One, to determine what species occur in various regions, has led to and continues to involve systematic studies of the fishes. The second aspect is to pick certain areas and to work them thoroughly and repeatedly so that information can be gained on the biology and ecology of oceanic fishes and their varied environmental roles.

The primary objectives of the present project are: 1) to complete the initial survey from 10 to 2000 fathoms along the Central American Coast and around Yucatan and into the western Straits of Florida, 2) to survey the hump of Brazil and the Fernando Noronha Archipelago, 3) to work along the coast of Colombia eastward from Cartagena and as time permits along the Antillean Arc, and 4) to continue the detailed studies of the fishes of the Straits of Florida with attention to seasonal, geographic, and bathymetric aspects and to the stages of the life history of the fishes involved.

SUPPORTED BY U.S. National Science Foundation

5.0069, STUDIES ON THE SPORT FISHERY FOR BILLFISHES AND TUNAS IN THE WESTERN ATLANTIC AND SOUTHEASTERN PACIFIC OCEAN.

D.P. DESYLVA, U.S. Dept. of Interior, Bureau of Sport Fish. & Wlfe. , *Panama City, Florida* 32401 (14-16-0008-775)

Objective: To carry out a survey of the sport fishery for billfishes and tunas in the western hemisphere.

Information will be obtained on: (a) what species of sailfish, marlins, swordfish, and tunas are caught by anglers in the western hemisphere; (b) their seasonal distribution; (c) size composition of catch; (d) an estimate of the number of anglers engaged in the sport fishery; (e) the economic value of the fishery; and (f) the effect, if any, on the sportfish catch by commercial fishermen as reflected in either decrease in size of fish landed by sportsmen or decrease in catch per unit of effort.

Questionnaires will be mailed to anglers, charterboat captains, angling clubs, marinas, and bait and tackle dealers who migh be able to supply the above information. Personal logs and records will be borrowed or copied, and the data reduced for IBM processing.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0070, ENVIRONMENTAL EFFECTS ON ISTIOPHORID FISH DISTRIBUTION

N.G. VICK, U.S. Dept. of Interior, Bureau of Sport Fish. & Wlfe., *Panama City, Florida* 32401

The objective of this study is to establish and test relationships between the seasonal distribution and appearance of istiophorid game fishes in the northeastern Gulf of Mexico and seasonally hydrographic features producing quasi-stationary eddies. Twenty-four cruises are planned to test previously determined relationships determined through the cooperative efforts of the Texas A & M Research Foundation, the Office of Naval Research, and the Bureau of Sport Fisheries and Wildlife. Predictive techniques will be tested and information made available to sportsmen. Technical data secured to aid in management recommendations for these particular species will also be tested. Certain biological materials, i.e., eggs, larvae, serum samples, and juveniles of these pelagic species will be collected for distribution to other laboratories.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0071, INVENTORY OF LARVAL FISH

L.G. MCBAY, State Game & Fish Commission, *Atlanta, Georgia*

Objectives: To identify the types of marine or brackishwater larval fish available for flooding into the public fishing area.

Procedures: A large number of samples have been taken in conjunction with this project which have not been analyzed. Several additional samples include larval species which have not been positively identified.

A considerable period of time will be necessarily allotted to this phase of the project. A collection of keys and references is partially complete. Others will be reviewed and utilized whenever possible in identifying the larval fish on hand from previous sampling.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Georgia State Government

5.0072, FISHES TAKEN INCIDENTAL TO SHRIMP TRAWLING

W.W. ANDERSON, U.S. Dept. of Interior, Biological Laboratory, *Brunswick, Georgia*

During the course of studies conducted on the white shrimp, Penaeus setiferus, along the south Atlantic cost of the U. S. during the period of 1931 to 1935, records were made on the numbers of the various species of fish taken incidental to trawling for shrimp.

Objectives are to make available in processed form, both tabular and graphic, the information on relative abundance of families and species of fishes, seasonal abundance of the species by regions, and related information, as revealed from shrimp trawling operations.

These records contain valuable information on relative abundance of the various families and species of fish, seasonal abundance of species in the various regions, and depict the average fish catch of a shrimp trawler during the period of operation. Information from this study will contribute much to the broader estuarine studies planned for future years.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0073, YOUNG FISHES OF A TIDAL ZONE

J.W. GEHRINGER, U.S. Dept. of Interior, Biological Laboratory, *Brunswick, Georgia*

During a 7-year period (1953-1960) a systematic collection of larval and juvenile fishes was obtained from three types of habitat in coastal Georgia; an outer beach on St. Simons Island--a favorite habitat for the young of many species; the marshes which lie between the barrier islands and the mainland--a rich habitat serving as nursery grounds for the young of many species of fish and shrimp; and about tidewater limits in the fresh water Altamaha River--the young of some marine species are frequently taken under such conditions.

Objectives are to determine the species and size groups of fish occurring in the several habitats, their seasonal distribution, apparent hydrographic preferences and related facts. Many of the series will be incorporated into life history studies on individual species--some of which are spawned in the open ocean but utilize coastal and estuarine waters during part of their early development. This study will contribute heavily to the broad estuarine studies planned for future years.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0074, IDENTIFICATION AND DESCRIPTION OF FISH LARVAE

J.W. GEHRINGER, U.S. Dept. of Interior, Biological Laboratory, *Brunswick, Georgia*

Project objectives are to identify to the most finite taxon possible (be it species, genus, or family) the fish larvae from collections of the M/V Theodore N. Gill made between February 1953 and December 1954 over the area from Cape Hatteras to the Bahamas and southern Florida, and from the beaches to beyond the Gulf Stream; seine collections; and other sources. Whenever possible, ontogenetic series which may be positively identified with larger fish to species are assembled and may be incorporated into early life history and other studies.

Knowledge of the fish occurring off the south Atlantic coast of the U. S. is limited; abundance of the various species is poorly known; and the life history has been determined on only a few species. We must be able to identify the fish larvae of the area if the early life histories are to be determined. With this accomplished, we can then determine the dispersal and abundance of many of the species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0075, INTRODUCTION OF MARINE GAME FISHES FROM AREAS IN THE PACIFIC

R.K. KANAYAMA, State Dept. of Land. Nat. Res., *Honolulu, Hawaii* 96813

Objectives: 1. To conduct follow-up observations and to document information relating to the probable establishment of exotic marine fish species introduced during previous segments and to ascertain if these species are established well enough to permit sport fishing for them.

Procedures: 1. For purposes of gathering data on the status of the exotic marine fish introductions released to date: (1) SCUBA dives will be conducted at sites known to harbor the exotic species or in areas where they have been reliably reported as having been sighted, and (2) commercial and sports fishermen will be interviewed in order to gather information on possible inadvertent capture of the exotics. 2. Sampling of the exotics may be attempted by use of fish toxicants, traps, seines, spears, angling or other suitable methods. 3. The feasibility of importing additional stocks of groupers, especially matapuu (Epinephelus fasciatus) and pukokoo (E. spiniger), and the snappers, tuhara (Lutjanus gibbus) and aaravi (Lethrinus sp.) should be investigated. The apparent failure of these species to establish themselves in Hawaii, thus far, is believed to be due mainly to insufficient numbers that were released originally.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Hawaii State Government

5.0076, INVESTIGATE TUNA SUBPOPULATIONS THROUGH THE USE OF BLOOD GROUPS AND INHERITED PROTEINS

K. FUJINO, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Honolulu, Hawaii* 96812

The objective of this project is to determine whether certain tuna resources are represented by a single ocean-wide population unit or are made up of smaller units, or subpopulations, of which the distribution of each is confined to smaller geographical area.

Such knowledge is important in understanding the effects of the fisheries on the resources and the development of proper management techniques for these resources.

Inherited characteristics of red blood cells, serum proteins and enzymes have been found in skipjack, yellowfin, bigeye, bluefin, and albacore tunas.

5. LIVING SYSTEMS (NON-HUMAN)

A series of extensive Pacific-wide population studies of skipjack tuna has indicated (1) that skipjack tuna taken from the western Pacific (Palau, Mariana, Okinawa, and Japan coast) belong to a subpopulation (or subpopulations) which does not appear in the central Pacific (Hawaii, Line, and Society Islands) and eastern Pacific (Baja California) and (2) that skipjack tuna appearing in the central and eastern Pacific do not constitute a homogeneous population unit. Relations of skipjack that appear in the central, north and south Pacific and eastern Pacific are now being studied.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0077, INCREASE EFFICIENCY OF HAWAIIAN SKIPJACK FISHERY

T.S. HIDA, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Honolulu, Hawaii* 96812

Skipjack tuna fishermen in Hawaii spend a substantial amount of their time fishing for the live bait necessary for skipjack fishing. It is generally agreed among members of the fishing industry and scientists that elimination of the baitfishing operation would result in a significant increase in the yield of skipjack from Hawaiian waters.

The present project is designed to establish a pilot scale baitfish-catching and baitfish-holding facility to determine if the separation of the baitfish activity from the actual skipjack fishing operation will result in an economical gain to the fishermen. The expected increase in catch would have to be large enough to compensate for the cost of operating the baiting facility. The establishment of a baitfish handling facility, then, will eliminate the need for a fishing boat to devote time and effort to a non-fishing activity. If successful, a full scale baiting facility could result in an additional 5-7 million pounds of skipjack landed per year. The present average annual catch is 10 million pounds.

SUPPORTED BY U.S. Dept. of Interior Bu. Comm. Fish.

5.0078, DEVELOP TECHNIQUES FOR CAPTURING JUVENILE TUNAS

B.E. HIGGINS, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Honolulu, Hawaii* 96812

Despite the many and intensive investigations during the past half century on the biology of the commercially valuable tunas of the Pacific Ocean, basic information of the younger stages is meager. Significant progress has been made in recent years on the identification, distribution, and abundance of larval tunas caught in plankton nets. Problems in identification of tuna larvae continue to exist, however, partly because large specimens needed to complete the size series necessary for identification are seldom captured by conventional sampling methods.

Juvenile tunas must be collected in large numbers in order to facilitate (1) the identification of immature specimens of each species and (2) the comparison of the immunogenetic affinities of skipjack and other tunas from different parts of the Pacific Ocean. Such information is required to delineate spawning areas and for an understanding of the relative contributions of the various subpopulations of skipjack and other tunas to the fisheries of the Pacific Ocean.

The objectives of the proposed investigation are (1) to develop techniques for capturing large numbers of juvenile skipjack and other tunas with a midwater trawl, (2) to investigate the feasibility of obtaining blood samples from juvenile skipjack and other tunas, and (3) to provide information on the bathymetric and areal distribution and abundance, ecology, morphology, and subpopulations of juvenile skipjack and other tunas. A 3-month trawling cruise was completed in summer 1967 in Hawaiian waters. A total of about 1000 juvenile and prejuvenile tunas was collected in 83 six-hour hauls. Blood typing at sea was found to be feasible for 10-15 cm. tunas. Future plans are to extend trawling effort to the equatorial central Pacific, the area which, by hypothesis, supplies the 70,000 metric ton per year eastern Pacific skipjack tuna fishery.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0079, INVESTIGATE SYSTEMATICS AND ECOLOGY OF TUNA LARVAE AND JUVENILES

W.M. MATSUMOTO, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Honolulu, Hawaii* 96812

Close resumblance among the young of various species of tunas renders their identification difficult. Differing results obtained by various workers have yet to be resolved. Resolution of the identification problem will enable a better definition of spawning areas and seasons for the various species of tunas.

All available characters--morphometric measurements, meristic counts, sequence of pigment changes, etc.--are utilized to arrive at definitive identifications. Greater emphasis is being placed in artificial fertilization methods to obtain larvae of known identity. Of those species whose identity is more definite, particularly skipjack, delimitation and definition of spawning areas in the equatorial central Pacific are being investigated.

Other methods of identifying young tunas are being investigated. Preliminary work has been initiated on the study of adult eye lens protein of various tunas using the starch gel electrophoresis methods to determine if species separation is possible. This study is being pursued further under contract and, if successful, the method will be used to identify the young.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0080, DETERMINE ALTERNATE LIVEBAIT SPECIES

E.L. NAKAMURA, U.S. Dept. of Interior, Behavior & Physiol. Prog. , *Honolulu, Hawaii* 96812

The Hawaiian fishery for skipjack tuna is believed to be capable of yielding more than double its present yearly landings. Since the fishery is dependent upon the use of live bait, live bait can be and often is a limiting factor in the landings. Of the combined time fishermen spend fishing for skipjack and catching bait, as much as 50 percent may be spent catching bait. If an alternate bait, one that is acceptable to fishermen and one which is as effective as that presently used by the fishermen, can be found and cultured, the amount of time spent catching natural bait could be greatly reduced. This in turn would greatly increase the amount of time spent fishing for skipjack. The live bait used by the fishermen is the nehu, Stolephorus purpureus, a small Hawaiian anchovy. It is a species which is not too hardy and often suffers high mortalities after capture. Thus, a substitute bait, one which is as good as the nehu in attracting skipjack to the stern of a vessel and which will withstand handling and which will be acceptable to the fishermen would be a great boon to the industry.

The objectives of this project are to identify and quantify the qualities of a good live bait, find one or more species possessing these traits, test them at sea in the fishery, and determine the best means of culturing those that are efficacious.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0081, INVESTIGATE POPULATION DYNAMICS OF ALBACORE

T. OTSU, U.S. Dept. of Interior, Tuna Ecology Program, *Honolulu, Hawaii* 96812

Information on the vital statistics of the albacore populations is necessary in order to estimate the maximum sustained yield of this resource. Furthermore, studies on the population dynamics of the albacore are required in anticipation of possible international discussions on management problems.

The tuna longline fishery based in American Samoa has grown rapidly since its start in 1954. There is now a sizeable concentration of Korean, Chinese, and Japanese fishermen based in American Samoa. There are nearly 200 vessels in the fleet. The landings of albacore, the principal species landed by the fleet, have increased from 338 metric tons in 1954 to about 26,000 metric tons in 1966. The South Pacific albacore, which seems to be the only longline-caught tuna that is not now being fished at the maximum rate, may not enjoy this distinction for very long, however. With the continually increasing fishing effort, it is vitally important that developments in this fishery be followed closely.

Excellent data from the fishery, obtained through the voluntary cooperation of the Japanese, Korean, and Chinese vessel operators, as well as biological data collected by our staff members stationed in Samoa, are being placed on IBM cards for analyses. Some analyses have been made and the results have been prepared for publication. These data will play an invaluable part in our study of the population dynamics of the species; to learn the responses of the albacore to environmental and to fishing pressure, and to determine the effect of each on the population size.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0082, ASSESSMENT OF CENTRAL PACIFIC TUNA RESOURCES

B.J. ROTHSCHILD, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Honolulu, Hawaii* 96812

The central Pacific is a vast area that contains many fish stocks that undergo varying degrees of exploitation. Some of these stocks, such as the tunas, are quite valuable commercially.

The objective of this project is to determine the location and abundance and population dynamics of the tuna fishery resources in the central Pacific and to develop techniques for optimum exploitation of these resources. In order to demonstrate these we need to know the expected apparent abundance and size distribution of each commercially important tuna species in the central Pacific.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0083, INVESTIGATE POPULATION DYNAMICS OF SKIPJACK TUNA IN HAWAIIAN WATERS

B.J. ROTHSCHILD, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Honolulu, Hawaii* 96812

The basic problem in this project is to evaluate the methods by which skipjack tuna (Katsuwonus pelamis) fishermen in Hawaii can obtain the maximum production of skipjack in terms of the amount of effort expended. This knowledge is closely tied in with the dynamics of the skipjack population, the environment, and the response of skipjack to variations in the environment and to exploitation by man. To evaluate these continuing population changes, we have used quantitative measures such as catch and effort data.

An approach to the problem is the OPERATIONS ANALYSIS project whereby observers are placed aboard the local skipjack fishing vessels during the peak fishing season to obtain detailed data of all aspects of the fishing operations, including baiting, scouting, and fishing. This project was implemented during the summer of 1967 and plans are to continue it over several seasons. The data will be analyzed and used as a basis for developing an optimum fishing strategy for the Hawaiian skipjack fleet.

In addition to fishery data, environmental data are also collected by the observers, in order that studies can be made of the relationship of skipjack tuna to the environment. The purpose is to improve fishing strategy by eliminating much of the unproductive scouting effort necessary under present operations.

There are other broad problems that bear on the specific problem. Since the Hawaiian skipjack fishery depends on livebait, the variation in availability and abundance of the bait is but one of these highly important problems. Size of vessel, fishing areas, the effectiveness of the fishing effort, and gear competition are other factors that need to be evaluated. Finally, there is a need to examine these problems using different types of data in order to refine our estimates.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0084, DEVELOP HIGH-SEAS TUNA FISHERY

R.S. SHOMURA, U.S. Dept. of Interior, Fishery Development Prog., *Honolulu, Hawaii* 96812

There is a growing body of scientific evidence which suggests that there is a large underutilized skipjack tuna resource in the central tropical Pacific Ocean. The potential annual yield has been estimated conservatively to exceed 150,000 metric tons. Present indications are that these skipjack cannot be caught with existing conventional fishing gear. The objective of this project is to develop a method of catching skipjack tuna in commercial quantities in the high seas of the central tropical Pacific Ocean. From present indication this will involve the design and development of a new fishing gear and technique or a modification of existing fishing gears and techniques.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0085, INVESTIGATE TUNA RESOURCES OF THE TRUST TERRITORIES

R.N. UCHIDA, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Honolulu, Hawaii* 96812

In the Pacific the annual landings of skipjack tuna have consistently ranked first among the commercially important tuna species. Despite the important of skipjack, the total knowledge of its biology is limited and relatively little is known of its movements, growth, population size, etc. The objectives of this program are: (1) collect biological and environmental data which will aid the U.S. fishing industry in the Trust Territory in understanding the resource and developing the industry to its maximum potential and (2) collect biological and environmental data which will add to our knowledge of the skipjack tuna and eventually lead to understanding the dynamics of the skipjack subpopulations. A skipjack sampling station in the Palau Islands has been initiated to (1) obtain data on the size composition of the tuna catch, (2) obtain catch and effort data of tuna fishing, (3) obtain samples of baitfish species for taxonomic studies, (4) obtain catch and effort data on baitfish catches, and (5) obtain through tagging, data on growth and movements of skipjack and yellowfin tunas in the Trust Territory region.

The Palau fishery is expected to be one of a number of fishing centers in the Trust Territory. Ecological studies of skipjack tuna will extend out on a broad scale to include at least the areas of Palau, Truk and Saipan.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0086, DEVELOP FISHERIES FOR NON-TUNA RESOURCES

H.O. YOSHIDA, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Honolulu, Hawaii* 96812

With the exception of the tuna fisheries, the commercial fishing effort in the Hawaiian Islands is restricted to the shallow waters near shore. The only fishing done in waters exceeding 50 fathoms in depth is bottom handline fishing for snappers.

The objective of this project is to evaluate the fishery resources of the deeper waters of the Hawaiian Islands chain by using various types of conventional fishing gears. If latent or underutilized resources are located, effort will be directed to encouraging the development of a commercial fishery.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0087, MECHANISMS AFFECTING THE VERTICAL AND HORIZONTAL DISTRIBUTION OF TUNAS AND RELATED SPECIES

H.S. YUEN, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Honolulu, Hawaii* 96812

Information on the vertical distribution of tunas and related species has been obtained in the past mostly from sampling by longlines and deep trolling. Because of the time-consuming nature of these techniques information has been collected at a very slow rate resulting in an incomplete picture of vertical distribution and limited to the depth range of the gear used. To increase ability to study horizontal and vertical distribution of tuna, behavior of subsurface schools, and movement of tuna schools, an especially designed high-resolution sonar was built and installed on the TOWNSEND CROMWELL. This instrument will provide the means of not only increaing the rate of collecting data but collecting data unobtainable by other methods, for example, the depth limits of occurrence, size of school, the rate at which depth changes are made, swimming speeds at various depths, shapes of schools, the pattern of depth changes which may be investigated in relation to other variable such as fish size, time of day, salinity, temperature, light, features of the ocean bottom, presence of other organisms, etc. The need for data on vertical distribution and the factors which control the vertical distribution is particularly acute for the Hawaiian fishery for skipjack.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5. LIVING SYSTEMS (NON-HUMAN)

5.0088, TAXONOMY AND DISTRIBUTION OF CLUPEOIDS AND REVISION OF THE GENUS ILISHA OF THE FAMILY CLUPEIDAE

R.V. SESHAIYA, Annamalai University, *Porto Novo, India*

The objective of this project is to collect and to preserve for study large series of the various kinds of clupeoid fishes from the estuaries and marine waters of India - with emphasis on the coastal area south of 13 degrees North latitude, as time and facilities allow. To study, compile and analyze data from, and to assess the taxonomy of the fishes of the clupeid genus Ilisha from the Indian Ocean; and to prepare this revision for inclusion in the 'Field Guide to the Clupeoid Fishes of the Indian Ocean.'

Specimens of clupeoid fishes will be collected from Indian waters by seine and other gear, and specimens not available elsewhere will be purchased from commercial fishermen. Descriptive field data will be recorded, especially on coloration of live and fresh specimens, and on schooling habits and behaviour. Coincident to this, small synoptic series of other families of fishes will be collected for other taxonomic studies. The specimens collected will be preserved in 10 percent Formalin. Specimens of the genus Ilisha will be sorted from the collections and retained for study; specimens of the remaining families will be made available to research workers studying those families in collaboration with the Field Guide. Counts, measurements and morphological data will be recorded from the specimens of Ilisha following procedures established for the Field Guide. The taxonomy of the clupeid genus Ilisha in the Indian Ocean will be revised. Illustrations of each species and a manuscript guide to their identification will be prepared; these will be incorporated into the manuscript on the 'Field Guide to the Clupeoid Fishes of the Indian Ocean.'

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0089, ECOLOGICAL INVESTIGATIONS OF SOME COMMON MARINE FISHES OFF THE MEDITERRANEAN COAST OF ISRAEL

L.B. ZISMANN, Israel Sea Fisheries Res. Sta. , *Haifa, Israel*

The objectives of this project are: 1. To find what forms enter the food web of fish on the continental shelf of Israel's Mediterranean coast and their relationships. 2. To find the distribution and range limits according to depths, bottom structure, and distance from shore of the more common species of fishes. 3. To assess the relative abundance of the fish species. 4. To collect general biological data such as: spawning period, seasonal fluctuations, size-range, etc., on those fishes important in the food web for which such data is not yet available. 5. To consider which factors may influence population fluctuations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0090, MOVEMENTS OF FRESHWATER CATFISH IN THE ESTUARIES OF SOUTHWEST LOUISIANA

W.G. PERRY, Rockefeller Wildlife Refuge, *Grand Chenier, Louisiana* 70643

Freshwater catfish will be collected, their total length and weights recorded, and the chemistries of the water from which they are obtained analyzed.

Recaptured fish will again be measured, weighed and water chemistry analyzed.

Objectives: 1. Determine if the freshwater catfish migrate in accordance with the salinity fluctuation. 2. Determine which of the catfish species present to be more tolerant to salinity.

SUPPORTED BY Louisiana State Government

5.0091, LAKE BORGNE-CHANDELEUR SOUND SYSTEM

J.G. BROOM, State Wildlife & Fish Comm. , *New Orleans, Louisiana*

Objectives: 1. Determine the distribution and density of the fauna of the phase area. 2. Determine the hydrography of the phase area. 3. Process the data.

Procedures and Work Schedule: 1. Weekly plankton sampling in the major passes and throughout the system with a 6-foot beam plankton net. 2. Weekly sampling throughout the major nursery areas with a 6-foot 1/4' mesh trawl. 3. Bi-weekly sampling throughout the major nursery and near offshore areas with trawls. 4. Bi-weekly seine sampling at selected sites. 5. Monthly benthic sampling at selected sites. 6. Collection of selected hydrographic information at each sample station and continuous recordings of salinity temperature and tidal movements at selected stations. 7. The processing, tabulating and summarizing of collections and raw data which are to be transmitted to the project leader at the marine laboratory for compilation, analysis and interpretation.

Location of Work: This area is defined by the Mississippi State line on the east and Bayou Terre aux Boeufs on the south. The area includes the following major bodies of water: Chandeleur Sound, Mississippi Sound, and Lakes Borgne, Pontchartrain and Maurepas.

Part 2 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Louisiana State Government

5.0092, TIMBALIER - TERREBONNE BAYS SYSTEM

J.G. BROOM, State Wildlife & Fish Comm. , *New Orleans, Louisiana*

Objectives: 1. Determine the distribution and density of the fauna of the phase area. 2. Determine the hydrography of the phase area. 3. Process the data.

Procedures and Work Schedule: 1. Weekly plankton sampling in the major passes and throughout the system with a 6-foot beam plankton net. 2. Weekly sampling throughout the major nursery areas with a 6-foot 1/4' mesh trawl. 3. Bi-weekly sampling throughout the major nursery and near off-shore areas with trawls. 4. Bi-weekly seine sampling at selected sites. 5. Monthly benthic sampling at selected sites. 6. Collection of selected hydrographic information at each sample station and continuous recordings of salinity temperature and tidal movements at selected stations. 7. The processing, tabulating and summarizing of collections and raw data which are to be transmitted to the project leader at the marine laboratory for compilation, analysis and interpretation.

Location of Work: This area extends from Bayou Lafourche on the east to Bayou Grand Caillou on the west, and includes Timbalier and Terrebonne Bays, Lake Pelto, and the intricate marshes north of these bodies.

Part 3 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Louisiana State Government

5.0093, BRETON SOUND - MOUTH OF MISSISSIPPI RIVER SYSTEM

J.G. BROOM, State Wildlife & Fish Comm. , *New Orleans, Louisiana*

Objectives: 1. Determine the distribution and density of the fauna of the phase area. 2. Determine the hydrography of the phase area. 3. Process the data.

Procedures and Work Schedule: 1. Weekly plankton sampling in the major passes and throughout the system with a 6-foot beam plankton net. 2. Weekly sampling throughout the major nursery areas with a 6- foot 1/2' mesh trawl. 3. Bi-weekly sampling throughout the major nursery and near offshore areas with trawls. 4. Bi-weekly seine sampling at selected sites. 5. Monthly benthic sampling at selected sites. 6. Collection of selected hydrographic information at each sample station and continuous recordings of salinity temperature and tidal movements at selected stations. 7. The processing, tabulating and summarizing of collections and raw data which are to be transmitted to the project leader at the marine laboratory for compilation, analysis and interpretation.

Part 4 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Louisiana State Government

5.0094, VERMILION - CALCASIEU - SABINE SYSTEM

J.G. BROOM, State Wildlife & Fish Comm. , *New Orleans, Louisiana*

Objectives: 1. Determine the distribution and density of the fauna of the phase area. 2. Determine the hydrography of the phase area. 3. Process the data.

Procedures and Work Schedule: 1. Weekly plankton sampling in the major passes and throughout the system with a 6-foot beam plankton net. 2. Weekly sampling throughout the major nursery areas with a 6-foot 1/4' mesh trawl. 3. Bi-weekly sampling throughout the major nursery and near off-shore areas with trawls. 4. Bi-weekly seine sampling at selected sites. 5. Monthly benthic sampling at selected sites. 6. Collection of selected hydrographic information at each sample station and continuous recordings of salinity temperature and tidal movements at selected stations. 7. The processing, tabulating and summarizing of collections and raw data which are to be transmitted to the project leader at the marine laboratory for compilation, analysis and interpretation.

Location of Work: This area extends from Point Chevreuil on the east to the Texas State Line. It includes East and West Cote Blanche Bays, Vermilion Bay, White, Grand, Calcasiou and Sabine Lakes, and the associated marshes.

Part 5 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Louisiana State Government

5.0095, ATCHAFALAYA RIVER - GAILOU LAKE SYSTEM

J.G. BROOM, State Wildlife & Fish Comm. , *New Orleans, Louisiana*

Objectives: 1. Determine the distribution and density of the fauna of the phase area. 2. Determine the hydrography of the phase area. 3. Process the data.

Procedures and Work Schedule: 1. Weekly plankton sampling in the major passes and throughout the system with a 6-foot beam plankton net. 2. Weekly sampling throughout the major nursery with a 6-foot 1/4 inch mesh trawl. 3. Bi-weekly sampling throughout the major nursery and near off-shore areas with trawls. 4. Bi-weekly seine sampling at selected sites. 5. Monthly benthic sampling at selected sites. 6. Collection of selected hydrographic information at each sample station and continuous recordings of salinity temperature and tidal movements at selected stations. 7. The processing, tabulating and summarizing of collections and raw data which are to be transmitted to the project leader at the marine laboratory for compilation, analysis and interpretation.

Location of Work: This area extends from Bayou Grand Caillou on the east to Point Chevreuil on the west, including Lakes Caillou, Mechant, DeCade, and Bays Caillou, Four League and Atchafalaya, and the lower Atchafalaya River swamp.

Part 6 of 6

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Louisiana State Government

5.0096, TRAMMEL NET SAMPLING IN ESTUARINE AREAS

J.T. DAVIS, State Wildlife & Fish Comm. , *New Orleans, Louisiana*

Objectives: 1. Determine fish population present in the areas of Lakes Maurepas, Pontchartrain and Borgne near the mouths of tributary streams. 2. Determine possible competitor species with estuarine species in these aras. 3. Establish dat on relative densities of anadromous species at different seasons of the year.

Procedures: 1. Monthly trammel samples will be taken at 30 designated stations. These include but are not limited to stream mouths, shoreline areas and passes. 2. Circle haul sets will be made with trammel nets of 1 inch mesh, six feet deep and 100 yards long. 3. All fish capured will be identified, weighed and measured. All data will be recorded for ADP.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Louisiana State Government

5.0097, REPOPULATION OF DECIMATED SECTIONS OF WARM-WATER STREAMS BY LONGEAR SUNFISH, LEPOMIS MEGALOTIS (RAFINESQUE)

T.M. BERRA, Tulane University of Louisiana, Graduate School, *New Orleans, Louisiana* 70118

00NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

5.0098, DETERMINATION OF THOSE MARINE SPECIES HAVING THE GREATEST KNOWN POTENTIAL FOR THE COMMERCIAL FISHERY

F.T. BAIRD, State Dept. of Sea Shore Fish. , *Augusta, Maine*

Objective: To determine those species having the greatest known potential.

Procedures: Only a limited portion of the overall objective will be accomplished during the initial period covered by this proposal. Depending upon the expressions of industrial interest and cooperation, concentration will be given to a limited group of species that indicate the greatest promise for successful commerical development. As this program develops, this limited list will be changed to fit existing demands or potentials.

During the first year, marine plants, primarily Fucus vesiculosus and Ascophyllum nodosum, will be collected seasonally, from areas along the coast, and furnished the Research Laboratory of Marine Colloids of Rockland, Maine, and other industrial users, for their industrial evaluation of alginic content and other products.

We will act during the first year on recent industry requests that we investigate the potentials for an expanded industrial fishery. The first year will be spend in assembling data on inshore fishing craft having a potential for this type of fishery, their capabilities, what industrial fish are being caught, where they are being caught, and what equipment is being used, with a view to the further exploitation of underutilized species for fish meal or marine protein concentrate. Also considered will be how an industrial fisheries operation can fit into the vessels present operations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Maine State Government

5.0099, BIOSTATISTICS OF HERRING

V. ANTHONY, U.S. Dept. of Interior, Biological Laboratory, *Boothbay Harbor, Maine* 04538

Immature herring (Clupea harengus harengus) of the Maine commercial fishery are being studied. Otoliths have been validated for aging the fish and are a basis for three studies: Growth, stock separation, and age structure of the fishery.

Basic parameters of population dynamics are being estimated from a combination of catch, sample and tagging data. Catch data of sardines collected since 1947 are being analyzed for changes in abundance by year class according to effort, growth, and time. These data are being compared with environmental conditions for long-term trends in connection with a parent-progeny relationship. Sardine sample data collected since 1963 provide information on meristic counts, morphometric data, age and growth. These data show a relationship of stock abundance and growth at age 1. Meristic counts and growth parameters of herring indicate stock differences and growth rates have been estimated for Maine, Nova Scotia, and Georges Bank.

SUPPORTED BY U.S. Dept of Interior - Bu. Comm. Fish.

5.0100, IDENTIFICATION OF WINTER FLOUNDER SUBPOPULATIONS

A. PETERSON, State Div. of Marine Fisheries, *Boston, Massachusetts*

To define the limits of the winter flounder populations or subpopulations and analyze the effect of present regulations on the fishery. Past tagging studies will be evaluated, experimental otter trawling will be analyzed, and the effect of regulations on exploitation based on the above data will be studied. Work will be conducted on this phase from July 1, 1966 through June 30,

1967. Most of the work will be done at the Sandwich office of the Division of Marine Fisheries.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Massachusetts State Government

5.0101, ATLAS OF MARINE FAUNA

E.D. MCRAE, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Gloucester, Massachusetts* 01930

Preparation of a series of atlases is being undertaken to graphically illustrate the seasonal commercial fishing grounds for various marine species in the area north of Cape Hatteras, N. C. A limited summary of supplemental or associated information concerning each species of fish (or shellfish) is included on text pages. Initial atlases will be concerned with the New England fisheries. Atlases on the fisheries of other sections of the general area will follow the New England series.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0102, EXPLORATION OF LATENT RESOURCES ON THE CONTINENTAL SHELF/SLOPE

E.D. MCRAE, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Gloucester, Massachusetts* 01930

Exploratory trawling explorations are conducted on the Continental Shelf and Slope in the area of Cape Hatteras, N.C. The purpose is to investigate the possible commercial potentials of unused fishery resources. Cruises to make a winter survey of the partial area between Cape Hatteras and Hudson Canyon are planned as initial field activity; other surveys of this area during different seasons are to be conducted later. With data on hand from completed seasonal surveys for the entire area, a logical utilization of total area productivity can be planned.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0103, POPULATION DYNAMICS OF NEW ENGLAND GROUNDFISH

R.C. HENNEMUTH, U.S. Dept. of Interior, Biological Laboratory, *Woods Hole, Massachusetts*

These studies are designed to determine the sustainable harvest in relation to effort of the more important groundfish that support the New England fisheries, and to conduct basic research on the population processes which control abundance and harvest. The more important species are haddock, cod, redfish, silver hake, flounders, and sea scallops. Data are obtained from analysis of the landed catch and from research vessel collections.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0104, BIOLOGICAL STUDIES OF NORTHWEST ATLANTIC GROUNDFISH

J.A. POSGAY, U.S. Dept. of Interior, Biological Laboratory, *Woods Hole, Massachusetts*

These studies are designed to provide basic information on the biology of groundfish of the Northwest Atlantic pertinent to management of the commercial fisheries. These studies yield information on the discreteness and degree of mixing of the different stocks of each species, the growth rates, the seasonal and secular changes in abundance and the relation of these changes to changes in environmental conditions. The species concerned are haddock (Melanogrammus aeglefinus (L)), cod (Gadus morhua (L)), silver hake (Merluccius bilinearis (Mitchill)), red hake (Urophycis chuss (Walbaum)), ocean perch (Sebastes marinus (L)), yellowtail flounder (Limanda ferruginea (Storer)), sea scallops (Placopecten magellanicus), and several other species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0105, FACTORS AFFECTING HORIZONTAL DISTRIBUTION OF MESOPELAGIC FISHES

R.H. BACKUS, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

This project is attempting to determine the patterns of horizontal distribution of mesopelagic fishes in the North Atlantic Ocean and to understand why these fishes are distributed the way they are.

SUPPORTED BY U.S. National Science Foundation

5.0106, POPULATION STRUCTURE OF THE ALEWIFE AND COREGONIDS

E.H. BROWN, U.S. Dept. of Interior, Biological Laboratory, *Ann Arbor, Michigan*

Study the population structure of the alewife and the deepwater coregonids of the Great Lakes with emphasis on conditions in Lake Michigan. Describe short- and long-term changes in abundance; areal and bathymetric distributions; relative discreteness of stocks; recruitment and mortality rates; age and sex composition and growth rates; and environmental effects, including intensity of the commercial fishery. Design and apply sampling procedures for use with trawls, gill nets, and other devices. Analyze data according to appropriate statistical and biometrical procedures, including use of electronic data processing.

This work and parallel studies on physiology and behavior and early life history are aimed particularly at understanding the changing ecology of Lake Michigan.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0107, LAKE SUPERIOR EXPLORATIONS

N.J. REIGLE, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Ann Arbor, Michigan*

The decline of high-value, food fish species and increases in populations of low-value fish stocks have left the Lake Superior fishermen with little chance to earn satisfactory incomes with traditional gill nets, trap nets and pounds nets. Systematic exploratory fishing operations are being conducted for locating and assessing the potential commercial yield of additional or alternate fish stocks; introducing existing gear from other areas or improved or new methods and equipment to allow efficient and economical harvest of these populations; surveying the physical characteristics of Lake Superior to ascertain suitability for various types of fishing gear; and determining the seasonal availability of various species in order to stabilize production and counteract the effects of seasonal gluts.

Otter trawls are being evaluated to determine the effectiveness of this gear for more economical exploitation of the abundant species such as chubs, smelt and suckers. Continuing studies will provide the basis for sound management of the available resource and permit economical, year-round utilization of underutilized species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0108, GREAT LAKES EXPLORATIONS

N.J. REIGLE, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Ann Arbor, Michigan*

Recent change in species composition and lack of technological progress in harvesting and handling populations of underutilized, low- value species have placed the Great Lakes commercial fishing industry in a poor economic position. Systematic exploratory fishing operations are being conducted for locating and assessing the potential commercial yield of additional of alternate fish stocks; introducing existing gear from other areas or improved or new methods and equipment to allow efficient and economical harvest of these crops, surveying the physical characteristics of the Great Lakes to ascertain suitability for various fishing methods; and determing the seasonal availability of various species in order to stabilize production and counteract the effects of seasonal gluts.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0109, ESTABLISHMENT AND PERPETUATION OF STOCKS OF EXPERIMENTAL FISH

G. WASHBURN, U.S. Dept. of Interior, Biological Laboratory, *Ann Arbor, Michigan*

This project is concerned with the development and application of techniques for the establishment and perpetuation of stocks of experimental fish primarily for studies of fish physiology and behavior at the Ann Arbor Biological Laboratory. Most fish are species present in the Great Lakes but which are not ordinarily maintained under artificial conditions. Studies are in progress to determine the most desirable type of closed water systems and to provide suitable environmental conditions to successfully complete all life-history stages. The project also requires studies of the development of special foods, treatment and prevention of diseases, the conditions that induce maturation and spawning, and the requirements for the production of viable eggs and young for a variety of species with a wide range of characteristics and requirements.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0110, EARLY LIFE HISTORY OF COREGONIDS

L. WELLS, **U.S. Dept. of Interior, Biological Laboratory, *Ann Arbor, Michigan***

Little or nothing is known about the early life history of coregonids, and of related ecological events and requirements. This study is exploring means of locating and collecting juvenile coregonids from hatching through their second year. Only recently has it been possible to collect larvae and fry in limited numbers, but methods to locate and catch young from the middle of their first year until the start of their third year have not been found. Once satisfactory means of collection have been developed, studies will be directed to their distribution, growth, and mortality in relation to the physical, chemical, and biological characteristics of the environment. The results of this study will be used in making estimates of recruitment and early mortality in population studies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0111, INTERRELATIONS OF ALEWIVES AND ASSOCIATED SPECIES

L. WELLS, **U.S. Dept. of Interior, Biological Laboratory, *Ann Arbor, Michigan***

The recent invasion and subsequent population explosion of alewives has prompted a comprehensive investigation into the interrelations of this species and others in Lake Michigan. The project represents the field phase of a broad study involving species interactions, behavior, and physiology. Current studies include food competition between alewives and associated species, effects on species composition and distribution of major food items (zooplankton), host-prey relationships, seasonal and depth distribution of alewife larvae and associated species, and other factors which may provide information on the mechanisms which permitted the alewife to dominate fish stocks of Lake Michigan with an apparent detrimental influence on endemic species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0112, ECOLOGY OF COMMERCIAL FISH SPECIES IN NORTHERN LAKE MICHIGAN

E.W. ROELOFS, **Michigan State University, Agricultural Experiment Sta. , *East Lansing, Michigan* 48824**

Objectives: 1. To study the distribution of ecommercially important fish species in northern Lake Michigan. 2. To determine the factors influencing the abundance of successive year-classes of fish. 3. To identify the number and distribution of subpopulations of certain species.

Methods: 1. Study catch records provided by commercial fishermen to the Conservation Department. 2. Determine age distribution, growth rates and morphometric characteristics of fish taken from various localities.

SUPPORTED BY Michigan State Government

5.0113, INVESTIGATION OF COMMERCIAL FISH POPULATIONS IN WESTERN LAKE SUPERIOR

UNKNOWN, **Univ. of Minnesota, Agricultural Experiment Sta. , *Saint Paul, Minnesota***

This project is designed to (1) investigate the causes of declining herring stocks and (2) the relation of this and other commercial species to changing ecological conditions and types of exploitation. It is proposed to sample larval stocks, concurrently caught predatory fish, and food sources in the Duluth and Apostle Island areas to determine the inter-relationship of the different species. These samples will be taken during spawning seasons and throughout the season during various life history stages. Samples will be taken with ground trawls, mid-water trawls, larval nets and naturalists' trawls from research vessel Siscowet. Simultaneous physical and chemical observations will be made. Program is designed to extend over a four-year period.

SUPPORTED BY Minnesota State Government

5.0114, A STUDY OF THE SEASONAL ABUNDANCE, DISTRIBUTION AND SPECIES COMPOSITION, WITH DEPTH, OF NEKTON FAUNA, WITH PARTICULAR EMPHASIS ON FISHES

C.E. DAWSON, **State Marine Conserv. Comm. , *Biloxi, Mississippi***

Objectives: To provide information on growth rates, morphological development and life histories of various species in the north-central Gulf and possibly leading to the development of methods for predicting year-class success of certain economically important species.

Procedures: 1) Monthly and, when possible, semi-monthly quantitative sampling with meter nekton nets and neuston nets at 10 fathom depth intervals to 30 fathoms will be made off the Mississippi coast. Course tracks and station locations would be plotted from radar and Loran fixes. 2) Day and night collections would be included to make most effective use of ship time and to allow for analysis of diurnal variations in collections. 3) Standardized drags would be made with 40 ft. trawls for qualitative and quantitative analysis of the bottom fish and invertebrate fauna. 4) Concurrent salinity and temperature determinations would be made at each collection site. 5) Laboratory studies would include identification of fishes and larger invertebrates. Meristic and morphometric observations on dominant organisms for developmental and growth rate studies. Species would be analyzed for variations in seasonal abundance with depth, salinity, temperature, etc.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Mississippi State Government

5.0115, SYSTEMATICS AND DISTRIBUTION OF WORMFISHES (MICRODESMIDAE)

C.E. DAWSON, **Gulf Coast Research Laboratory, *Ocean Springs, Mississippi***

Wormfishes (Microdesmids) are a little known group of burrowing or inhabiting, elongate, marine and estuarine fishes which are apparently restricted to lower temperate, sub-tropic and tropic environments. They are presently recorded to a maximum depth of about 50'. Although poorly represented in museum collections, wormfishes may be locally abundant, with as many as fifty or more being taken in a single sample. Aside from a brief description of swimming behavior in one species, there is little or no information on their behavior, life history or biology.

The Investigator's current studies on the morphology and osteology of the wormfishes have resulted in the discovery of a number of heretofore unknown or unrecognized characters of systematic value which permit definitive approach to the phylogenetic systems within the group as well as some insight into its higher relationships within the Gobioidea. He has, with minor exceptions, examined all known specimens, but a number of problems of distribution, species divergence and variation cannot be solved until more study material is available. Thus, the proposed research will be for the continuation of these studies and intensive collecting in all known areas of distribution of the family of these studies and intensive collecting in all known areas of distribution of the family Microdesmidae. This work will result in a revision of the family supplemented with detailed accounts of distribution and ecology together with life history notes for each of the twenty-seven fishes now recognized as comprising the Microdesmidae.

SUPPORTED BY U.S. National Science Foundation

5. LIVING SYSTEMS (NON-HUMAN)

5.0116, EXPLORATORY COLLECTION AND CARE OF FISH FOR TESTING AT TIBURON

T. LANE, U.S. Dept. of Interior, Fish Pesticide Res. Lab. , *Columbia, Missouri* 65201

The objectives of the work are to survey the sources of experimental fish for use in pesticide bioassay work and to develop an efficient means of harvesting and holding the fish at Tiburon, California. Examination of areas in San Francisco Bay and in the Sacramento-San Joaquin Delta, commercial sources, and culture of fish at Tiburon will be explored. Fishes will be collected, brought to the laboratory, and held under various conditions of water flow, time, feeding, and space conditions to measure the best procedure for each species and size group.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0117, DISTRIBUTION AND MIGRATION OF CENTRAL AMERICAN FRESHWATER ELASMOBRANCHS

UNKNOWN, Univ. of Nebraska, Graduate School, *Lincoln, Nebraska* 68508 (N00014-66-C-0161)

This is a continuation of an existing study for the clarification and documentation of the problematical movement of the freshwater or bull shark (Carcharhinus leucas) and the sawfish (Pristis perotteti) from the marine environment of the Caribbean Sea into the freshwater system of Lake Nicaragua, Nicaragua, as well as of the pattern and duration of these movements. The adaptation in osmoregulation for this shark from roughly saline sea water to the low salinity lake waters represents a phenomenon of wide biological interest. The program sets up tagging and recording stations along the river outlet of Lake Nicaragua to determine whether or not this migration actually occurs. Trials will be made of a promising new sonic emission tag by which fish movements can be followed from a boat or passively recorded from shore monitoring stations.

The study of sharks and other potentially dangerous fishes, such as the sawfish, is of prime interest to the Navy in light of the growing incidence of lightly protected Naval personnel in swimming, diving, and emergency operations. The freshwater shark is regarded as a dangerous member of this group, and there are authenticated records of its attack on humans in the ONR-supported publication, 'Sharks and Survival.'

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0118, TEMPERATURE TOLERANCE OF MARINE ANIMALS THROUGH BEHAVORIAL RESPONSES

D.W. BRIDGES, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

Introduce acclimated and non-acclimated marine organisms into waters of various temperature regimes; observe and measure behavioral patterns such as rate of feeding of fishes, cirral activity of barnacles and pumping rate of bivalves. Diagnose range of temperature in which experimental animals are able to maintain normal behavior as well as determine the thermal death point(s) for these organisms.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0119, DISTRIBUTION OF YOUNG STAGES OF COASTAL FISHES

J. CLARK, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

A survey is to be made of the continetal shelf from Cape Cod, Mass. to Cape Lookout, N.C., utilizing the research vessel Dolphin. The goal is to determine relative abundance of young of the major game species in the open estuaries, along the coast, and seaward onto the continental shelf. A series of 14 transects will be established; each extending from the shore to at least the 50-fathom contour. Eight cruises will be made at approximate 1-1/2 month intervals throughout one year. Collecting stations will be spaced along the lines at approximate 10 mile intervals; somewhat closer near shore. At each station along the survey transects a 30-minute oblique tow will be made with 1) a modified Gulf III sampler for larvae and 2) a special 20 foot mid-water trawl for juvenile fish. All fishes taken will be identified to species and isometric charts of abundance of eggs, larvae, and juveniles will be drawn.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0120, TRACKING MIGRATIONS OF BLUEFISH POPULATIONS ALONG ATLANTIC COAST TO LEARN BIOLOGY OF THE SPECIES (MIGRATORY HABITS OF BLUEFISH)

J.R. CLARK, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

It is the purpose of this project to determine population structure of the bluefish species, abundance of the populations, times and routes of migrations of the different populations and rates of mortality of the different populations.

The plan of work is to carry out strategic tagging of 5000 bluefish from southern Florida to Cape Cod. Phase One will be to develop methods, determine suitability of various tag types and tagging methods, and to conduct limited tagging trials. Phase Two will be to conduct field tagging to test hypotheses regarding major populations of bluefish, which will be carried out at seasonal centers of abundance of bluefish in Florida, North Carolina, New Jersey and Cape Cod.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0121, LIFE HISTORY AND BEHAVIOR OF FISHES ON ARTIFICAL REEFS

L. OGREN, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

Determine the species composition, relative abundance, and temporal distribution of fish on artificial reefs and compare results with fish populations occupying natural reefs and areas devoid of reef habitat. Observe and describe the specific attraction to artificial reefs by fish in terms of nutrition, protection, reproduction, growth, and other life needs. Make direct observations of the fish fauna with SCUBA and correlate these observations with similarly conducted dives on natural reefs and barren bottom areas. Make underwater transects with a towed sea sled in each study area to aid in establishing the general faunal features of the locality. Quantitatively sample the reef sites and adjacent study areas with standardized fishing gear, i.e., fish traps. Record results and release fish at place of capture. Periodically sacrifice a sub-sample to study food habits and gonad development.

Relate biological observations to the physical characteristics of the environment and to the artificial habitat.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0122, INFLUENCE OF UNLIMITED FOOD SUPPLY ON RHYTHMIC ACTIVITY OF BLUEFISH

B.L. OLLA, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

To learn what effect an unlimited food supply has on rhythmic activity of bluefish: introduce several thousand live prey fish into the experimental tank. Measure rhythmic activity as well as time and intensity of feeding throughout the day and night for a seven to ten day period. Tabulate, plot and analyze resulting data to bring out statistically significant tendencies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0123, HYPOTHETICAL DISTRIBUTION OF 14 SPECIES OF ATLANTIC COASTAL GAME FISHES

L.A. WALFORD, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

Description of Work: 1. Assemble, tabulate and plot all available records of occurrence and catch data regarding the following species: Bluefish, bonito, cod, red drum, croaker, red hake, mackerel, porgy, black sea bass, spanish mackerel, spotted sea trout, spot, tautog, bluefin tuna. 2. Collate plotted records with monthly maps of average sea temperatures resulting from work unit 2512-03. 3. Using all existing information and logical assumptions regarding responses of these fishes to temperatures, construct monthly hypothetical total distributions. Report the results in the graphic and written presentation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0124, CREEL CENSUS OF SUMMER FLOUNDER SPORT FISHERY IN GREAT BAY, NEW JERSEY

W.S. MURAWSKI, State Div. of Fish & Game, *Trenton, New Jersey*

A. Project Objectives: To study these aspects of the life history of the summer flounder, Paralichthys dentatus, which are pertinent to the management of its fisheries, such as migration, spawning, distribution of the young and growth. Job Objective: The job objective is to conduct a creel census of a segment of the small boat fishery in Great Bay, N.J. during the summer months in order to provide an index to the quality and quantity of the summer flounder sport fishery catch for New Jersey waters.

B. Procedures: A complete creel census will be made at one small boat livery and ramp on Great Bay every Wednesday, Thursday and Saturday during the months of June, July, and August. Direct interviews will be made at dockside by a creel census technician to determine the catch per effort and the size composition of the catch.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
New Jersey State Government

5.0125, SCHOOLING BEHAVIOR IN FISHES

E. SHAW, Amer. Museum of Nat. History, *New York, New York*

Brief description of research project: Schooling in fishes represents a biosocial behavior which exhibits several distinctive features: movement of individuals in the same direction, parallel orientation to one another with more or less equal spacing, and synchronized turning in a manner that still has not been fully analyzed.

The principal investigator has been studying schooling under previous grants, her current grant being C-10832. Further studies on schooling are planned along the above lines of investigation. School structure will be analyzed three-dimensionally. The role of the visual and lateral line sensory systems in parellel orientation will be evaluated. The development of schooling and the influence of experiental factors will be observed and experimental procedures will be extended. A synthesis of these lines of investigation should provide a more comprehensive understanding of bio-social phenomena at this phylogenetic level, and should also provide a greater understanding of the factors that give rise to the formation of schools and to their maintenance in characteristic geometric patterns.

SUPPORTED BY U.S. National Science Foundation

5.0126, COLLECTION, COMPILATION, AND ANALYSIS OF GULF CATCH STATISTICS AND LOGBOOK DATA

R.B. CHAPATON, U.S. Dept. of Interior, Biological Laboratory, *Beaufort, North Carolina* 28516

To furnish basic information for interpreting the results of the biological investigations of the gulf menhaden fishery, the historical and current landing records by vessel, date, and locality and logbook records of fishing activities are required. Current records and historical records are being obtained from the reduction plants. Automatic data processing will be used for tabulations and analyses. Logbooks and fishing charts will be introduced in the fishery beginning in April 1964.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0127, TAGGING

R.L. DRYFOOS, U.S. Dept. of Interior, Biological Laboratory, *Beaufort, North Carolina* 28516

Results from size and age comparison, morphology and population studies, and estimating year class strength need confirmation from tagging and subsequent recovery. In addition, reliable information on movements, migrations, and mortalities often can be obtained only from the direct results of marking and recovery data.

The mass catching, handling, and processing of menhaden require marking of large numbers of fish and the automatic recovery of those marked. Initial inquiries into marking with stains or pigments and subsequent recovery with an electronic device proved unsuccessful for field use.

Preliminary experiments have shown that marking with ferromagnetic, internal tags and magnetic recovery during the reduction process are feasible. These findings completed the first phase of the study. The project is inactive at the present time, pending allocation of funds with which to conduct a field experiment.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0128, INVESTIGATION OF THE BIOLOGY AND POPULATION STRUCTURE OF GULF MENHADEN

P.L. FORE, U.S. Dept. of Interior, Biological Laboratory, *Beaufort, North Carolina* 28516

Measure of the species composition of the landings and related information on the distribution and abundance of three species reported in the Gulf of Mexico are needed to understand the Gulf menhaden resource. Whether one or more populations of gulf menhaden supports the fishery and the biological characteristics of each also must be known to fulfill the objectives of the program and furnish the industry the information they need.

Species identification by external characters, vertebral counts, and other internal structures is an early objective. Collections of gulf, yellowfin, and finescale gulf menhaden were obtained from 1959 to date. These were examined to provide a field guide for the identification of the species.

An analysis of vertebral numbers of gulf menhaden collected from Florida to Texas in 1960 was made to determine the range in morphological variations and for indications of population differences. No conclusions of population heterogeneity were made, although there were significant differences in the mean numbers of vertebrae from the eastern and western gulf.

Juveniles were collected in 10 selected estuaries during September 1963 for a study of morphological variations during successive years.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0129, SAMPLING OF THE ATLANTIC COMMERCIAL CATCH

M.A. JUDY, U.S. Dept. of Interior, Biological Laboratory, *Beaufort, North Carolina* 28516

Determination of length, weight, sex, sexual maturity, and age composition of the Atlantic menhaden catch by geographical locality is accomplished by daily sampling of the landings at the principal ports throughout the range and season of the purse seine fishery. Landings, by vessel, for each day's fishing are obtained from reduction plant records. Logbook records of date, time, locality, and estimated catch for each purse seine set is kept by fishermen aboard a representative number of vessels. These data are used to provide calculated numbers and weights for each year class contribution to the fishery.

Fish are measured, weighed and stage of sexual maturity, designated by gonad weight, are recorded. Age is determined by annular marks on the scales. Distances between annuli are recorded. At present the information is analyzed and stored on hand-sorted punch cards. Automatic data processing with machine-punched cards is proposed. Cards on hand document the Atlantic menhaden fishery from 1952 to 1963. Summaries for 1952-58 are published, with 1959-60 in press, and 1961-63 under preparation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0130, POPULATION STUDIES

J.H. KUYKUHN, U.S. Dept. of Interior, Biological Laboratory, *Beaufort, North Carolina* 28516

Knowledge of the identity and distribution of species subpopulations is needed to understand the extent of the Atlantic menhaden resource and the effects of environmental factors and fishing upon it. Species identity and indications of population structure can be obtained from studies of the morphology and biology of the fish over their range. Occurrences of larvae, juveniles, and adults help determine the distributions of populations.

Variation in vertebral numbers of juveniles from localities along the Atlantic Coast have shown consistent differences between populations north and south of Long Island. Spawning adults from nearby localities also show similar differences. In addition, the hypothesis of an additional southern subpopulation from Cape Hatteras southward is being investigated.

The first phase of a study of the distribution and abundance of two or more species of menhaden in Florida has been completed. Yellowfin menhaden, Brevoertia smithi, occurs in Florida but is being little utilized at present. Continuing studies are concerned with determining population structure and identity of this species complex. Methods will include a detailed structural and serological comparison of the species and experimental cross-fertilization for possible hybridization.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0131, ESTIMATION OF JUVENILE ABUNDANCE IN ESTUARINE NURSERIES

W.F. TURNER, U.S. Dept. of Interior, Biological Laboratory, *Beaufort, North Carolina* 28516

Yearling fish provide a substantial portion of the menhaden landings in the Gulf of Mexico. Estimation and prediction of the incoming year class abundance can be made from measures of the relative abundance of juveniles in the estuaries in the preceding year. Methods employed will be the same as for the Atlantic menhaden and will include catch per unit of effort, measures with standard haul seine and trawl gear, fin clipping and recovery, and ground and aerial school counts.

Aerial counts of schools from Florida to south Texas were made in October 1962 and 1963.

Catches by haul seines and trawls were made in selected estuaries during September 1963. These observations mark the beginning of the project for gulf menhadens.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0132, SYSTEMATICS, ZOOGEOGRAPHY, AND ECOLOGY OF ELASMOBRANCHS OF THE WESTERN ATLANTIC OCEAN

F.J. SCHWARTZ, Univ. of North Carolina, Institute of Marine Science, *Morehead City, North Carolina* 28557

All aspects of the systematics, zoogeography, biology, and ecology of Western Atlantic elasmobranchs are being investigated. Studies are aided through local tagging efforts.

SUPPORTED BY University of North Carolina

5.0133, FISH COLLECTION OF NORTH CAROLINA AND WESTERN ATLANTIC FISHES

F.J. SCHWARTZ, Univ. of North Carolina, Institute of Marine Science, *Morehead City, North Carolina* 28557

A curated and catalogued collection of fishes is maintained for research, teaching and systematic work. Species consist of freshwater and Western Atlantic fishes with emphasis on those now occurring in North Carolina.

SUPPORTED BY University of North Carolina

5.0134, LAKE ERIE INVESTIGATIONS - LIFE HISTORY AND ABUNDANCE OF THE YELLOW PERC

H.D. VANMETER, U.S. Dept. of Interior, Biological Station, *Sandusky, Ohio*

The abundance of year classes, rate of growth, and the effects of exploitation are determined from data collected from fish captured in experimental and commercial nets. Information on food, spawning habits, distribution, competition with other species, and other life history aspects are obtained from collections of fish taken in experimental gear. Environmental factors--oxygen, water temperature, bottom organisms, plankton, water currents, seiches, and the interrelations with other species of fish are determined from limnological and fish-population data obtained with the fish collections.

Current studies nearing completion include the age and growth, abundance, and history of the commercial fishery for this species from 1949 through the calendar year 1966, spawning and fry development, age and size at maturity, fecundity, and food habits. Studies of the effects of environmental conditions upon this species are described elsewhere as separate projects.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0135, FLUCTUATIONS IN SPECIES COMPOSITION AND YEAR-CLASS STRENGTH OF COMMERCIAL LANDINGS

H.D. VANMETER, U.S. Dept. of Interior, Biological Station, *Sandusky, Ohio*

This investigation requires the collecting, in spring and fall, of scale samples and mensural data from the species available in the commercial landings at fish houses at representative ports in the western, central and eastern basins of the lake. Species composition of the catches becomes evident from what is available for sampling. Examination of the scales of walleyes and yellow perch is kept current and year-class contributions to the catches of these species are summarized annually.

Scale samples and data for the remaining commercial species are made available to other investigators or are filed for future studies.

Reports summarizing major segments of these data for the walleye, sheepshead, and yellow perch are currently in preparation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0136, PRELIMINARY STUDY TO DETERMINE ABUNDANCE AND RECRUITMENT OF BOTTOMFISH OFF OREGON

R.L. DEMORY, State Fish Commission, *Astoria, Oregon* 97103

This study will undertake to determine the factors associated with and responsible for the variations in abundance and year-class strength of Dover sole and other groundfish species supporting the commercial trawl fishery of Oregon. Dover sole data from past years will be reviewed and combined with data from the current sampling program. Collections of juvenile groundfish will be examined and identified, fish stomachs examined for larvae and juvenile fish, and collection trips taken aboard commercial shrimp vessels and chartered trawl vessels to collect juveniles. These collection and sampling procedures will be part of an overall assessment program to determine year-class strength, survival rates of juveniles, and juvenile abundance.

The work will take place at the ports of landing along the coast of Oregon and on the trawl fishing grounds along the adjacent Oregon coastline. Laboratory work will be handled at the Research Laboratory, Astoria, Oregon.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Oregon State Government

5.0137, OREGON FISHES - THEIR CLASSIFICATIONS, DISTRIBUTIONS AND LIFE HISTORIES

C.E. BOND, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

Objectives: In general, to provide basic information concerning Oregon's fish fauna. Immediate objectives involve compilation of faunal lists, keys to Oregon marine fishes and studies of the Zoogeography and speciation of freshwater fishes. A special investigation will assess populations of certain estuarine fishes.

Work Proposed: A. Freshwater studies: Collection, cataloging, and ecological analysis will be continued in order to provide faunal lists and Zoogeographical Information. Collections of lampreys from inland as well as coastal areas must precede studies of speciation in this group. B. Marine studies: For lists and keys, additional collection, cataloging and taxonomic studies will be necessary. Populations of bay fishes will be studied by mark-and-recapture methods.

SUPPORTED BY Oregon State Government

5.0138, OREGON FISHES - THEIR CLASSIFICATION, DISTRIBUTION AND BIOLOGY

C.E. BOND, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

The object of this project is to provide basic information relating to Oregon's fish fauna, including both marine and freshwater species. Considerable effort has gone into field work and the maintenance of a reference collection. Studies of the biologies of several species have been carried out. Keys and lists are being prepared and distribution records kept.

SUPPORTED BY Oregon State Government

5.0139, EARLY LIFE OF BOREAL FOOD FISH AND SHELLFISH

W.J. MCNEIL, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

Objectives: 1. Determine the time and place of occurrence of eggs and larvae of food fish and shellfish off the Oregon coast. Systematic collections will be made at sea and taxonomic descriptions in the laboratory. 2. Determine time and place of high and variable mortality of selected species. 3. To associate mortality of selected species with biological and physical-chemical factors in the environment. 4. To elucidate the nature of mortality processes through experimentation.

SUPPORTED BY Oregon State Government

5.0140, EVALUATION, COORDINATION, AND PLANNING OF PACIFIC SALMON AND STEELHEAD RESEARCH AND MANAGEMENT ACTIVITIES

L.A. VERHOEVEN, Pacific Salmon Inter. Agcy. Co, *Portland, Oregon*

To promote more efficient use of research and management efforts through better determination of needs, coordination of activites, evaluation of projects, dissemination of information and planning of programs-both short-and long-rang.

Present objectives are to compile an annual bulletin of coastwide commercial and sport fishery catch statistics, update inventories of current salmon and steelhead research work, formulate long-range plans to maintain and enhance the resource, update assessments and compilations on the status of Pacific Coast salmon and steelhead stocks, review and evaluate major fishery problems and recommend solutions or procedures for dealing with these problems, sponsor and stimulate workshops in connection with these problems, and update the Salmon Compendium by including literature from 1960 to the present.

There is no precise timetable for the accomplishment of objectives but certain broad limits can be established for some items. The Salmon Compendium should be updated for the period 1960-64 by December 1968. Research inventories will be updated in 1968 and again in 1970. Catch statistics will be compiled annually. Major fishery problems will be dealt with at the estimated rate of five problems per year. Longrange planning will continue through the term of this program. Compilation of statistics, updating of inventories and status reports will be accomplished from information received from various state and federal agencies. The updating of the Salmon Compendium will be done through library research contracted to the Fisheries Research Institute at the University of Washington. The resolution of major fishery problems will be undertaken by th Technical Committee of the Pacific Salmon Inter-agency Council with the assistance of experts in various fields through workshops, subcommittees, and other forms of communication.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Oregon State Government

5.0141, INVESTIGATE THE FEASIBILITY OF INTRODUCING SOCKEYE SALMON INTO RESERVOIRS

L. KORN, State Fish Commission, *Portland, Oregon* 97201 (14-17-001-1429)

Determine the ability of juvenile sockeye to survive and rear in and emigrate from certain reservoirs. Catalog reservoirs in Oregon as to their physical, chemical, and biological properties; evaluate these with respect to the potential for rearing sockeye.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0142, SURVEYS OF SPAWNING SALMON

R.E. LOEFFEL, State Fish Commission, *Salem, Oregon*

Purpose: To establish trends of abundance for spawning salmon in Oregon.

Methods: Designated index areas of many streams are surveyed during spawning periods to determine peak counts of salmon. The counts are refined into a composite fish per mile index for each species and all stream areas surveyed.

Results: The trend in spawning populations of the various species aids in determining management policies.

Reports: Annual unpublished reports are prepared and maintained on file.

SUPPORTED BY Oregon State Government

5.0143, ALBACORE TUNA

R.E. LOEFFEL, State Fish Commission, *Salem, Oregon*

Purpose: To monitor the landings of albacore in Oregon fishery and collect information on the life history, behavior and environment of the albacore.

Methods: To conduct fishermen interviews and examine logbook data. To conduct a pre-season exploratory and oceanographic cruise annually in early July. Do limited tagging to learn more about migrations, age and growth of the albacore.

Results: The success of the albacore fishery fluctuates widely from year to year and is closely related to the ocean environment. The annual cruise enables us to gather environmental data to compare with catch and effort data. The cruises have enabled us to catch fish for tagging and have resulted in the early start of the commercial fishery on several occasions when we located quantities of tuna. The limited tagging work done to date shows that fishermen in Oregon waters and Japanese fishermen in the central and western north Pacific fish on the same stocks of albacore.

Reports: Annual reports, cruise reports and catch and effort data reports. A summary report of pre-season cruises (1959-67). A summary report of all OFC tag recoveries (in preparation).

SUPPORTED BY Oregon State Government

5.0144, POPULATION ESTIMATES OF JUVENILE COHO SALMON IN SIX COASTAL STREAMS

R.E. LOEFFEL, State Fish Commission, *Salem, Oregon*

Purpose: To determine if annual fluctuations in abundance occur in juvenile coho populations and if the abundance can be related to parent abundance, returning adults and environmental conditions.

Methods: Stream sections have been identified. Each year the population of juvenile salmon in these sections is estimated. Results are compared to changes in temperature, flow, adult spawning populations, etc.

Results: Data suggest that abundance of juveniles during summer low-flow period not related to numbers of parent spawners but indicative of success of brood year.

Reports: Annual unpublished reports of population estimates.

SUPPORTED BY Oregon State Government

5.0145, MANAGEMENT OF THE OREGON TRAWL FISHERY

J.M. MEEHAN, State Fish Commission, *Salem, Oregon*

Purpose: Monitor and regulate the fishery to obtain optimum yield and prevent over exploitation.

Methods: Interview fishermen for catch and effort data. Collect and analyze market samples for length-frequency, sex, and age. Estimate mink food and rockfish composition. Make periodic flights to survey foreign trawl fleets.

Results: We maintain continuous records of landing by species or groups, where these fish are caught and effort expended. Results are used for coast-wide management purposes such as the recent removal of the restriction of winter petrale sole landings.

SUPPORTED BY Oregon State Government

5. LIVING SYSTEMS (NON-HUMAN)

5.0146, MONOGRAPH OF THE FISHES OF THE ORDER PLECTOGNATHI

J.C. TYLER, Acad. of Nat. Sci. of Phila., *Philadelphia, Pennsylvania* 19103

This investigation is a continuation of research initiated under GB-5102. The Plectognathi are widely, but not unanimously, recognized as one of the major orders or phyletic lines of teleostean fishes derived of a perciform ancestry. The primary reason that there is any doubt about the naturalness of the Plectognathi is that it is a highly diversified order which has not yet been adequately defined. There are only about 320 Recent species of plectognaths, but the order is much more diversified than the majority of fish groups of a comparable number of species.

The investigator will systematically describe and illustrate the osteology of representatives of each of the presently envisioned 12 families of plectognaths, and of additional species of especially distinctive subfamilies when necessary, in order to compare the diversity of structural types within the order and to arrive at a meaningful classification that is in accord with what reexamination of the fossil record indicates. The usually reductive trends in the evolutionary pattern leading to the diversity of the plectognaths will be analyzed, and the osteology of acanthuroids surveyed in order to re-evaluate the probability of their close relationship to the plectognaths.

SUPPORTED BY U.S. National Science Foundation

5.0147, MIGRATORY HABITS OF LARGE SHARKS

J.G. CASEY, U.S. Dept. of Interior, Marine Game Fish Research Lab., *Narragansett, Rhode Island* 02882

To determine the migratory patterns of sharks occurring in North Atlantic coastal waters from Maine to North Carolina.

The plan of work is to: (1) tag sharks in the course of longline fishing operations conducted by the Sandy Hook Marine Laboratory under an additional shark study project; (2) supply tagging materials and instructions to cooperating sportsmen and sporting clubs who have volunteered assistance; (3) continue tagging through October, 1966, at which time tag return data will be collected and analyzed.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0148, FAMILIAL RELATIONSHIPS IN TELEOST FISHES

C. HUBBS, Univ. of Texas, Graduate School, *Austin, Texas* 78712

It has recently been proposed that classification of teleost fishes should be based on phyletic lines. This philosophy has resulted in extensive rearrangement of families. Use of phyletic trends emphasizes parallel evolution of morphology. The absence of fossil evidence makes it difficult to determine which feature is a parallelism and which represents convergence. The interaction of two sets of chromatin in a single cytoplasmic environment is not likely to be influenced by parallel or convergent evolution, so it can be used to determine which alternative is actually parallel and which is actually phylogeny.

SUPPORTED BY U.S. National Science Foundation

5.0149, LIFE-HISTORY AND BIOLOGICAL WORK IN THE RESTORATION AND MANAGEMENT OD SPECIES OF IMPORTANCE TO THE FISHERIES OF THE VIRGIN ISLANDS

A.E. DAMMANN, Virgin Isls. Off. of The Gov., *Saint Thomas - Charlotte Amal.*, *Virgin Islands*

Phase 03: An analysis of the observed and collected materials from each station should eventually yield data related to species composition, population size, reproduction, feeding, and other biological functions related to fin fish and shellfish populations.

In addition to plankton collections, nets, traps, hook and line, poisons, spears, snares, and other collecting techniques will be employed to obtain and observe specimens.

It is believed that the catamaran research vessel with its glass-bottomed well, large live well, provisions for SCUBA, and all its communications gear, will play an important role in this phase of the project. We anticipate much direct observation that could not readily be achieved by any other equally economical means.

Arthur E. Dammann and personnel to be hired or used on a collaborative basis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Virgin Islands Government

5.0150, BIOLOGY OF ANADROMOUS ALOSIDS

J. DAVIS, Virginia Inst. of Marine Sci., *Gloucester, Virginia*

OBJECTIVES: 1. To obtain a collection of data on which to base estimates of the composition of the spawning run of alosids in 1967 and the mortality rates of the species. 2. Estimation of the catch of each species of Alosa in each river system. 3. Finding the spawning sites of alosid fishes in the York River system and in some of the tributaries to the Potomac River.

PROCEDURES: 1. Age and spawning history will be determined by counting rings and spawning checks on scales. 2. Catch records will be obtained from a sample of each type of gear in each river and the total number of gears of each type will be counted monthly. Total catch will be estimated by multiplying the average catch of the sample gears by the total number of units of gear. 3. The mainstream and its tributaries will be sampled for eggs, ripe fish, and newly hatched larvae. Presence of any of these will indicate a spawning area. Areas in which young fish are caught will be considered to be nurseries.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Virginia State Government

5.0151, ESTIMATION OF PARAMETERS OF STRIPED BASS POPULATION AND DESCRIPTION OF THE FISHERY OF LOWER CHESAPEAKE BAY

E.B. JOSEPH, Virginia Inst. of Marine Sci., *Gloucester Point, Virginia* 23062

The objectives of this research are three-fold: 1. To obtain an estimate of the age composition of the stocks of striped bass in lower Chesapeake Bay, with special reference to seasonal variation, 2. To determine the age selectivity of the major types of fishing gear that are removing striped bass from the population, and 3. To measure the relative strength of the incoming year class by means of young fish surveys.

The segment of the research covered by this contract period extends from 1 May 1967 - 30 November 1967. Since there are seasonal aspects to the above mentioned objectives, this research will not be completed in this period, but will be carried into future contract time segments.

Age composition will be based on samples of catch obtained from pound-nets and fyke-nets in the James, the York and Rappahannock Rivers. Age determination will be based on the scale method.

Age selectivity will be determined for all major types of fishing gear, including hook and line, in use in the lower Chesapeake Bay area and compared to non-selective gear operating in the same river.

Young fish surveys will utilize both trawl and seine collections in all Virginia rivers supporting spawning populations.

The scientific personnel on this project will include, in addition to the principal investigator, Mr. Clarence Richards, Mr. Victor Burrell, and one PhD level biologist to be added. This staff will be assisted by technical and clerical help.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Virginia State Government

5.0152, THE DETERMINATION OF THE AVAILABILITY OF SEA ROBINS

E.B. JOSEPH, Virginia Inst. of Marine Sci., *Gloucester Point, Virginia* 23062

The objective of this phase will be to determine whether or not sea robins are equally available to bottom trawls in day and night. We anticipate that two species of sea robins Prinotus carolinus and P. evolans will comprise a significant portion of the total benthic industrial resource in the area under investigation. The diel availability of those species will be determined from analysis of catches from a series of experimental trawl tows conducted at frequent intervals through 24 hour periods. For consistency, the tows will be made in the same depth range, and so far as is possible on the same concentration of fish. This experiment will be done from the R/V Pathfinder working as close to Chesapeake Bay as concentrations of fish will permit. This work will be performed in November, 1965.

The information obtained in this phase will be used in formulating a sampling program to be described in a separate phase.

Part 1 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Virginia State Government

5.0153, WINTER DISTRIBUTION OF FISHES

E.B. JOSEPH, Virginia Inst. of Marine Sci. , *Gloucester Point, Virginia* 23062

The objective is to determine the pattern of distribution in winter of ground fishes of potential industrial importance on the Continental Shelf between Cape May, N. J. and Cape Hatteras, N. C. Trawl tows will be made at predetermined stations and temperature and salinity of the bottom waters will be determined.

The quantity of each size category of each species caught will be recorded on IBM cards with the associated physical data. Correlations between physical features of the environment and distribution of fish will be sought. Data gathering will extend from 1 January to 15 March 1966. Analysis will follow. Part 4 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Virginia State Government

5.0154, SPRING DISTRIBUTION OF FISHES

E.B. JOSEPH, Virginia Inst. of Marine Sci. , *Gloucester Point, Virginia* 23062

The objective is to determine the pattern of distribution in spring of ground fishes of potential industrial importance on the Continental shelf between Cape May, N. J. and Cape Hatteras, N. C. Trawl tows will be made at predetermined stations and temperature and salinity of the bottom waters will be determined.

The quantity of each size category of each species caught will be recorded on IBM cards with the associated physical data. Correlations between physical features of the environment and distribution of fish will be sought. Data gathering will extend from 15 April to 30 June 1966. Analysis will follow.

Part 5 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Virginia State Government

5.0155, DISTRIBUTION, AGE GROWTH, AND MORTALITY STUDIES OF SALT WATER FISHES OF IMPORTANCE TO SPORT FISHERMEN

C.E. RICHARDS, Virginia Inst. of Marine Sci. , *Gloucester Point, Virginia* 23062

Data on Pogonias cromis (black drum), Sciaenops ocellata (red drum), Leiostomus xanthurus (spot), Rachycentron canadum (cobia), and other fishes is obtained by various sampling methods carried out in Chesapeake Bay and the waters off Eastern Shore Virginia and from tagging studies. Analysis includes analog computer studies of age and growth and population dynamics. Studies began in 1960 and are continuing.

SUPPORTED BY Virginia State Government

5.0156, INTERVIEW AND OBSERVATION

E.B. JOSEPH, State Comm. of Fisheries, *Newport News, Virginia*

The objective of this phase is to obtain information concerning the distribution of species of ground fish of potential industrial importance in the shelf waters between Cape May, N.J. and Cape Hatteras, N.C. Information will be obtained by interviewing trawlermen who have fished the area and also by placing observers aboard trawlers fishing in the area. Data obtained will be stored on IBM cards to facilitate retrieval and analysis. Hampton, Virginia will be the primary interview site.

Information obtained by interview and observation will supplement data on distribution of fishes obtained by our exploratory trawling. Both sources of information will contribute to our understanding of the biology of fishes of the Continental Shelf. Time schedule: November 1965 - June 1966.

The technical personnel participating in this phase will be: Edwin B. Joseph, Ph.D., (Project leader), John J. Norcross, M.S., Jackson Davis, Ph.D., Peter Eldridge, M.S., James Sterling, B.S., a technician and a graduate student assistant.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Virginia State Government

5.0157, TAG LOSS

P.K. BERGMAN, State Dept. of Fisheries, *Olympia, Washington*

Tagged coho smolts now in storage at the Department's Minter Creek Hatchery will be weighed, measured, tags excised, and decoded. Data will be placed in a computer program so that differential tag loss can be studied, particularly in relation to fish size. Additionally, fish will be tagged under improved techniques and equipment adjustments to determine means of achieving more positive tag retention. X-ray techniques will also be used to study tag placement. Phase 1 will include lake poisoning where 1964 brood coho were reared and residualism occurs. Work will commence in June 1966.

Existing data coming from the first full cycle (1962) brood) of tagged coho in storage at Minter Creek will be programmed and analyzed.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5.0158, TAGGING ENGLISH SOLE, PETRALE SOLE, AND PACIFIC COD

E.K. HOLMBERG, State Dept. of Fisheries, *Olympia, Washington*

The objectives under the tagging phase will be to provide information relative to the migrations and status of English sole, Petrale Sole, and Pacific Cod stocks, on which the Washington bottom fishery operates. The stock used for tagging will come from catches made from chartered commercial fishing vessels, during the normal fishing seasons for the respective species. Charters will include in addition to the vessels, crews, gear, supplies, and meals. Technical staff conducting the tagging will be assisted by the charter crews. Charter tagging trips will vary in time from 10 to 15 days according to conditions.

English Sole - Approximately 5,000 fish will be tagged with serial numbered Peterson disc tags. Tagging will commence as soon after October (1966) as possible, located off the N. W. Washington coast. Fish will be sexed and measured.

Petrale Sole - Approximately 5,000 fish will be tagged with serial numbered Peterson disc tags. Tagging will occur during November (1966), in the Estevan Deep. This work will provide information on the efficacy of the present winter closure regulations. Condition of the fish will be observed and measurements taken as above.

Pacific Cod - Approximately 5,000 fish will be tagged with serially numbered large plastic darts. Tagging will occur during January 1967, in the Strait of Juan de Fuca, offshore from Port Angeles. Untagged fish will be random sampled for a determination of sex ratios. Measurements as above will be taken.

(Part 1 of 3)

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5.0159, TAG RECOVERY, ENGLISH SOLE, PETRALE SOLE, AND PACIFIC COD

E.K. HOLMBERG, State Dept. of Fisheries, *Olympia, Washington*

The objective of the tag recovery phase will be to ascertain the fate of fish tagged earlier, and in turn, interpret and relate the tagging results to questions of migration, rates of exploitation and mortality which recovered tags may reveal alone, or in conjunction with other biological data collected both on the tagging grounds and through sampling. Tags will be a means of determining the identity of stocks and their population.

Scheduled daily port visits at which tags will be recovered, will be at Seattle, Everett, Anacortes, Bellingham, and (or) Blaine. These visits will be in conjunction with the Department's fisherman interview and biological sampling program now in its 13th year.

Rewards of up to one dollar ($1.00) will be paid for tags recovered, as follows: Fifty cents ($.50) for each tag returned, twenty-five cents ($.25) for each tag with accurate fishing information provided, twenty-five cents ($.25) for each tagged fish in a frozen condition.

For purposes of data analysis, Walford's method will be used for asymptotic length, Von Bertalantfy's Growth method will be followed and Peterson's Population Estimate will be attempted. The experiments are designed for data treatment by computer analysis methods.

Part 2 of 3.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5.0160, SAMPLING OF GROUNDFISH STOCKS

E.K. HOLMBERG, State Dept. of Fisheries, *Olympia*, *Washington*

The objective of sampling will be to provide background information to complement the tagging studies. Samples of 400 fish of each species involved in Subproject 1 will be taken at approximately fourteen day intervals throughout the season, as fishing conditions dictate. Fish will be sexed, measured to the nearest mm., and weighed to the nearest gram. Sampling will occur at landing ports of Bellingham and Seattle.

English Sole - The opercular bones will be taken for age determination. Catch curves (weighted) of age composition will indicate recruitment and total mortality rates.

Petrale Sole - Otoliths will be collected for age determination. Other biological data will be treated as above.

Pacific Cod - Age determinations will utilize length measurements using Harding's Method. Other data will be treated as above.

Detailed examinations of biological material and data treatment will be conducted at the Department's University of Washington Laboratory. During those sampling trips, where time will not permit sampling a full 400 fish without delaying processing plant operations, fish will be purchased and returned to the laboratory for detailed examinations.

Part 3 of 3

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5.0161, COHO MARKING

H. SENN, State Dept. of Fisheries, *Olympia*, *Washington*

Coho marked under this phase will utlimately contribute to a better knowledge of the contribution of hatchery propaged coho to the several fisheries of Washington, Oregon, and Canada.

Marking of 1965 brood Puget Sound hatchery coho will commence in June. These will include four double-fin marks established at a meeting of the Pacific Marine Fisheries Commission.

Marking procedures will be those previously established for marking fall chinook under the Columbia River Fishery Development Program.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5.0162, SAMPLING OF MARKED COHO

H. SENN, State Dept. of Fisheries, *Olympia*, *Washington*

Coho of 1965 brood, previously marked at the Department's Columbia River hatcheries, will be sampled during October and November to determine the numbers of marked and non-marked which will be released in the spring of 1967. This sampling procedure is one established and in use for fall chinook under the Columbia River Fishery Development Program.

Part 2 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5.0163, RECOVERY OF MARKED COHO

H. SENN, State Dept. of Fisheries, *Olympia*, *Washington*

During the late summer and early fall of 1966, marked coho of the 1964 brood, liberated from Puget Sound hatcheries, will be returning to hatchery racks as jacks. Where possible, these will be recovered by hatchery crews. Others of the same brood year will appear in the fishery, where they will come within the scrutiny of existing catch sampling programs. Recovery data will be forwarded to the Oregon Fish Commission Data Processing Laboratory at Clackamas, Oregon, under procedures now followed in the recovery of marked fall chinook for the Columbia River hatchery evaluation program. Additional mark recovery data will be supplied by Canada, from similar sampling conducted in the British Columbia fishery. Procedures for reporting will conform to those established between the state of Washington and British Columbia for the mutual exchange of marked and tagged fish data.

Part 3 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5.0164, MARKED COHO LIBERATION

H. SENN, State Dept. of Fisheries, *Olympia*, *Washington*

Coho of the 1965 brood, at both Puget Sound and Columbia River hatcheries, will be liberated at the hatcheries' sites in the customary manner for yearling coho, during early spring months of 1967. These will compise both marked and unmarked fish. Marked to unmarked ratios will be established for each hatchery.

Part 4 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5.0165, MANAGEMENT OF COLUMBIA RIVER COMMERCIAL FISHERY

A.L. OAKLEY, State Dept. of Fisheries, *Seattle*, *Washington*

Purpose: Regulation of commercial fishery to obtain maximum sustained yields from the resource.

Methods. Predict run size and timing for certain anadromous species, monitor commercial catch and escapement and compile detailed landing statistics for purposes of evaluating commercial fishery. Analyze escapement-production data to establish optimum escapement levels for important runs.

Results: Columbia River fish runs are being harvested commercially on a biological basis. Declines in certain stocks can be evaluated, based on data collected in this program, and corrective action suggested.

Results: Annual progress reports. Publications have been completed on fecundity of Columbia River chinook, timing of Williamette River spring-run chinook in the Columbia River, racial timing of chinook salmon in the lower Columbia River, trends in production rates for upper Columbia River runs of salmon and steelhead and a depensatory process based on the concept of hunger. A manuscript relating to the effect of environmental changes on reproductive curves was submitted for publication. Several reports relating to fish passage and spill patterns at Ice Harbor Dam were submitted to the U. S. Army Corps of Engineers.

SUPPORTED BY Washington State Government
Oregon State Government

5.0166, ANALYSIS OF JAPANESE CATCH STATISTICS

R.A. FREDIN, U.S. Dept. of Interior, Biological Laboratory, *Seattle*, *Washington* 98102

The Japanese high seas salmon fishery annually operates about 370 catcher boats over several hundred square miles of ocean during a 60 day fishing season, exploiting major salmon runs of both Kamchatka and Alaska.

The work of this project consists of collating and analyzing fisheries statistics and biological data from the Japanese high seas salmon fishery and Japanese research vessels in the North Pacific Ocean to (1) determine annual fluctuations in abundance of the 5 species of salmon in the high seas fishing areas and causes of same, (2) ascertain seasonal and intra-seasonal changes in the temporal-spatial distributions of the 5 species of salmon and relate these to oceanographic conditions, maturity schedules, timing of inshore runs or other factors, (3) assess effects of high seas salmon fishing on the conservation and productivity of Bristol Bay sockeye salmon and northern Alaska chinook salmon runs, (4) provide background information for predicting the size and high seas rate of exploitation of Bristol Bay sockeye salmon runs, and (5) determine potential effects of expanded high seas salmon fishing operations on U.S. salmon stocks.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0167, POPULATION DYANMICS (BIOMETRICS) OF EXPLOITED FISH GROUPS OF THE NORTH PACIFIC OCEAN AND PACIFIC COAST

R.A. FREDIN, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

Research on the population dynamics of exploited fish stocks of the North Pacific Ocean and Pacific Coast of North America is conducted for the purpose of evaluating the current status of the stocks, measuring the degree of utilization, and determining the conditions necessary for achieving maximum average yields. Fishery statistics and biological data on Pacific salmon, Pacific halibut and other exploited fish stocks, such as king crab and bottom fish, are analyzed for fluctuations in abundance and changes in composition and characteristics of the stocks.

Classical and newly developed or modified analytical techniques are used to estimate population parameters, including stock sizes, fishing and natural mortality rates and growth rates, and to measure the reliability of such estimates.

Various statistical methods and mathematical population models are employed in studying causes of fluctuations in abundance of stocks, estimating the effects of fishing on sustainable yields for single and mixed stocks, determining yield per recruit and stock-recruitment relationship, and estimating optimum stock sizes and maximum average yield.

Oceanographic and meteorologic observations and measurements might contribute significantly to the interpretation of biological information on population sizes and changes.

Most of the data compiled and analyzed in this research project are recorded on punched cards or magnetic tape and processed by electronic computers.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0168, BOTTOMFISH EXPLORATIONS

C.R. HITZ, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Seattle, Washington* 98102

Bottomfish exploration is primarily concerned with benthic vertebrate populations. The objectives are to define, in time and space, the quantitative and qualitative distribution of aquatic benthic vertebrate resources having a potential for commercial utilization, and to provide an appraisal of these resources.

In FY 68 a cruise in scheduled to develop new techniques in the use of rollers on the footrope of a bottom trawl to permit trawling on rough bottom, and to explore rough-bottom areas off the Washington coast. Also proposed is a cruise to assess deep-water sablefish resources off Washington and Oregon.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0169, ADULT SALMON BEHAVIOR STUDIES IN RIVERS AND AT DAMS (SONIC TRACKING)

J.H. JOHNSON, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

This project seeks information which will contribute to a sound assessment of the effect of reservoirs and dams on anadromous fish runs, specifically on adult salmonids returning to Columbia River system spawning areas. Such an assessment requires an accurate knowledge of migration timing and spawning area locations before dams are constructed, and of the amount and nature of mortality resulting directly from fish passage over dams.

The project's primary research tool at present is the sonic fish tag, a miniature high frequency sound transmitter attached directly to the fish. Sonic tagged fish can be tracked individually from boats, their continuous movements noted in precise detail, or their progress and dispersion upstream can be measured by means of automatic recording monitors placed at intervals along the shore above a tagging site.

Studies in progress are attempting to pinpoint the causes for losses of adult salmon between Bonneville, Priest Rapids, and Ice Harbor dams using sonic tracking devices and automatic recording monitors placed at strategic intervals along the Columbia River and tributary streams.

Studies are planned on the behavior of adult salmonids in estuaries, using sonic tracking techniques to examine migration in relation to tides, freshwater inflow, salinity, and other environmental factors.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0170, OCEAN GROWTH AND MORTALITY OF SALMON

J. LALANNE, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

Tagging studies have demonstrated that it is not presently feasible to obtain reliable estimates of short-term natural mortality for salmon. Consequently, these mortality studies are being deferred with a report on 'Tagging Experiments on the Natural Mortality of Bristol Bay Sockeye Salmon (O. nerka) during their last few weeks at Sea.' Growth work will continue and includes a study of the marine growth of chum salmon (O. keta) based on periodic sampling at sea and a study of the relationship between the scale growth-body growth of chinook salmon (O. tshawytscha).

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0171, GROUNDFISH INVESTIGATIONS (POTENTIAL YIELD OF UNDERUTILIZED GROUNDFISH STOCKS)

H. LARKINS, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

Program objectives: short-range, to determine maximum sustainable yield for fish stocks that are currently underutilized or are being endangered by foreign fishing; long-range, to predict year-class fluctuations and distribution patterns allowing maximum harvest of Pacific Northwest groundfish stocks, and to develop the scientific background necessary for sound international management of such stocks.

Recent increases in program funds and personnel will allow many of the planned research phases to be started earlier than anticipated or operated at an accelerated level. Along with the biological work already in progress with Pacific hake and Pacific ocean perch (size, age, maturity, growth, mortality, and recruitment) we are beginning: a groundfish tagging research and development project; a biological survey of latent fishery resources; an evaluation of economic conditions that affect the groundfisheries and resultant catch per unit of effort statistics; an egg and larval fish identification study; and a cooperative age reading unit with the Washington Department of Fisheries.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0172, PELAGIC FISH EXPLORATIONS

M.O. NELSON, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Seattle, Washington* 98102

Pelagic fish exploration is concerned with pelagic vertebrate populations. The objectives are to define, in time and space, the quantitative and qualitative distribution of aquatic pelagic vertebrate fish resources having a potential for commercial utilization, and to provide an appraisal of these resources.

Emphasis during FY 68 will continue on hake. Extensive use will be made of acoustical counting equipment to quantify hake populations.

A new project to assess the offshore saury resources was initiated in FY 68. One three-week cruise was conducted using various colored lights to attract the saury to the vessel, and lift and gill nets were employed to harvest them.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5. LIVING SYSTEMS (NON-HUMAN)

5.0173, ADULT MIGRATION RATES

H.L. RAYMOND, U.S. Dept. of Interior, Fish Passage Res. Program, *Seattle, Washington*

The environment in the Columbia River has been changed from a free-flowing stream to a series of dams and impoundments. In a few short years a similar change will take place on the lower Snake. How will this progressive change in environment affect the populations and timing of the many races of salmon migrating upriver to spawn? Data obtained from this program would be helpful in: (1) planning adequate fish facilities, by knowing numbers and time of arrival at planned dams; (2) managing the fishery by knowing time of arrival and expected numbers of the major races of chinook salmon in the commercial fishing area; (3) identifying spawning beds in areas soon to be inundated by new dams; and (4) planning rehabilitation of depleted runs by seeding these runs with other races having similar timing.

The technique involves sonic tagging a specific number of salmon at Ice Harbor Dam on the lower Snake River and monitoring their progress upstream to their spawning ground by means of recorders at intervals up the main river and in the major tributaries. Gradual expansion of the program would follow until the entire Columbia River System is under study.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0174, FISH POPULATION STUDY

R.P. SILLIMAN, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

This is a study of the response of fish populations to fishing and to environmental changes. It will be conducted by two means: (a) Experimental laboratory fish populations (b) Mathematical models of populations.

Initial experiments are testing the interaction effects of holding populations under three different food levels and three levels of fishing intensity (3 x 3 table). An analog computer is being used for the simulation of fishing yields through the continuous solution of differential equations. Future experiments will study the effect of other variables, such as temperature and water chemistry.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0175, FISH POPULATION STUDY

R.P. SILLIMAN, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

The purpose of this work is to study the detailed responses of fish populations to varying fishing rates and environmental conditions. Work is being performed with experimental laboratory populations in aquaria, and with mathematical models. Experimental animals include Lebistes reticulatus, Xiphophorus helleri, Tilapia macrocephala and T. mossambica. An analog computer is employed in constructing mathematical models.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0176, MARINE FISH BEHAVIOR

R.B. THOMPSON, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

Researchers will conduct basic and applied behavior studies on currently exploited and potentially exploitable marine species.

The objective is to improve the efficiency of harvesting and managing marine fishery resources through the better understanding of the continuous behavior patterns of the target species. Fundamental principles of fish psychology will be developed; patterns of behavior will be investigated, analysed, and described so these can be used to best advantage by the fishermen and the resource managers. Studies will be made of the biological and exploitative significance of the different behaviour patterns; especially the controlling stimuli and physiological mechanisms involved in feeding, individual and group movements and migrations, reproduction, and the reactions of fishes within the zone of influence of fishing gear.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0177, DROPOUT OF SALMON FROM GILL NETS

R.B. THOMPSON, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

The objectives are to study the effects of gill nets on adult salmon in the commercial fishery in terms of dropouts and mortalities.

1. Within the artificial environment of a salt water pond observe the dropout ratio, mortality rates, behavior patterns, external injuries, and measure fatigue of salmon exposed to gill nets.
2. Determine the effects of gill nets on adult salmon in the inshore commercial fishery.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0178, ESTUARINE WATER QUALITY AND FISH DISTRIBUTION

D.E. BEVAN, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

Increasing demands upon the water resources of the estuary of the Nooksack River threaten alteration in water quality. The project will develop measures of 'fishes well-being' in areas of dispersal of pulp and paper effluents. Patterns of feeding and the physiological condition of juvenile salmon moving through the estuary will be related to environmental conditions. Quantitative measures of the fishes distribution and their condition will be related to chemical and hydrographic monitoring of the estuary.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Washington

5.0179, FORECAST OF KODIAK ISLAND PINK SALMON RUNS FROM ABUNDANCE OF JUVENILES IN ESTUARIES

D.E. BEVAN, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The objective of this work is to develop a method of predicting the returning runs of pink salmon to Kodiak Island based on the relative numbers of juvenile salmon migrating seaward. The annual variations in abundance of juvenile salmon are estimated from the results of surface trawling in 4 bays which are representative of most streams on Kodiak Island. Since the sampling gear and methods developed for this work are new and have potential for widespread use, it is essential that the dynamics of the sampling be determined in order to achieve its most efficient use. Such a study will be accomplished by analysis of performance tests of the net to be conducted at Kodiak Island in conjunction with the trawling surveys. These tests will enable us to determine the variability and efficiency of the tow net.

Commensurate with the need for improving this forecast technique, the recent development of a method for mass marking salmon fingerlings by means of sprayed fluorescent pigment promises to be a valuable aid in determining mortality, migration, and quantitative abundance of young salmon. A feasibility test will be conducted at Kodiak Island to determine whether a marking program successfully can be integrated with juvenile salmon indexing studies.

SUPPORTED BY University of Washington
Association of Pacific Fisheries
U.S. Dept. of Interior - Bu. Comm. Fish.

5.0180, TAGGING SALMON IN THE OFFSHORE WATERS OF THE NORTH PACIFIC

R.L. BURGNER, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The main objective of the research is to study the distribution, abundance, migrations, and general ecology of the principal stocks of salmon, both Asian and North American throughout the North Pacific Ocean and Bering Sea. The tagging is part of a large scale research program being pursued by the International North Pacific Fisheries Commission (Canada, Japan, and the United States) in order to provide data to implement the terms of a tripartite treaty between the three countries. The research is coordinated with similar research by Canada, Japan and the United States. The work is also coordinated with a number of other approaches to the problem including research on methods of identification by means of serology, meristic counts, morphological features and parasites. Methods used are to catch salmon of all species and age groups at sea with purse seine gear and longline gear, tag them and later recover them from the commercial fisheries around the Pacific rim. Scales are taken for age determination, and some specimens examined internally for parasites, maturity, and stomach contents. Oceanographic data on temperature, salinity and currents are collected at all fishing stations. Operations in 1967 will be directed at the migration and ecology of juvenile salmon during their early ocean residency.

The work is being performed in the Gulf of Alaska and in the Bering Sea from the United States and Canadian coast westward to 180 degrees. The project started in fiscal year 1955 and the termination date is indefinite.

SUPPORTED BY University of Washington
U.S. Dept. of Interior - Bu. Comm. Fish.

5.0181, A PROGRAM FOR THE TRAINING OF STAFF MEMBERS FROM THE SCHOOL OF FISHERIES OF THE CATHOLIC UNIVERSITY OF VALPARAISO CHILE

J. LISTON, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

In many of the protein-deficit countries of the world, the food potential of the sea has remained largely untapped because of lack of technical proficiency. Chile's 2,900-mile coastline represents a valuable fisheries resource, insufficiently exploited because of the shortage of trained manpower. To build the necessary scientific competence, the School of Fisheries, founded at the Catholic University of Valpariso about ten years ago, has made constant efforts to develop its facilities and strengthen its curriculum. Scientific and technological studies at the School are combined with practical experience, in a four-year course leading to a bachelor's degree. In addition to academic work in fisheries technology, food processing, biochemistry, marine biology, and oceanography, its students spend at least three semesters on fishing boats and in fish canneries and a processing plant.

SUPPORTED BY Rockefeller Foundation

5.0182, INTERRELATIONS OF SMELT WITH NATIVE SPECIES

M.M. BAILEY, U.S. Dept. of Interior, Research Station, *Ashland, Wisconsin*

The smelt, which was first observed in Lake superior in 1930, is now perhaps the most abundant species in the lake. Life history studies have shown that the smelt occupy the same areas and utilize the same food as juvenile lake trout, lake herring, and some species of chubs. Evidence also exists that the smelt has all but replaced the coregonines as the major food of the adult lake trout. The habits of the lake herring appear to be affected by concentrations of smelt in certain areas of the lake.

Present research is directed toward the interrelations of smelt and the early life history stages of lake trout, whitefish, lake herring, and chubs. Inquiry is made into the extent of predation upon eggs and larvae of other species and the degree of competition for food and space. Using commercial fishery statistics and data collected by the Bureau's research vessel Siscowet, comparisons are made between fluctuations in abundance of smelt and other species. This study may lead to other areas of research regarding the feasibility of introducing desirable species which would utilize the abundant but yet commercially unimportant smelt.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0183, CHARACTERISTICS OF LAKE SUPERIOR WHITEFISH

M.M. BAILEY, U.S. Dept. of Interior, Research Station, *Ashland, Wisconsin*

The drastic decline of the lake trout in Lake Superior has made the whitefish of prime importance to the economy of Lake Superior commercial fishermen. Critical examinations of the several populations in the lake are maintained to provide data for sound management and rational utilization of the species. Periodic examinations are made of commercial landings and data are collected on size, age, sex distribution, and maturity. Assessment studies of spawning populations in western Lake Superior are conducted annually by the Bureau's research vessel Siscowet. Tagging studies currently in progress are designed to yield information on exploitation rates and homing instincts of the spawning population. Information gained from these studies may lead to recommendations for adjustments in the legal size limit for optimum utilization.

Future plans call for a comprehensive study of the early life history of the whitefish. Data will be collected on factors affecting year-class strength, survival of eggs and fly, and the distribution and habits of O- and I-group whitefish. Special emphasis will be given to the interrelations between whitefish and other species, both native and exotic.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0184, LIFE HISTORY OF THE BURBOT AND LONGNOSE SUCKER

M.M. BAILEY, U.S. Dept. of Interior, Research Station, *Ashland, Wisconsin*

An understnading of the biology of Lake Superior requires knowledge of the life histories of fish inhabiting the lake. The burbot and longnose sucker are abundant in Lake Superior but little is known of their role in the biological community.

Present research is directed twoard life history aspects of the species--distribution, age, growth, maturity, fecundity, and food--and their interrelationships with other species. The data and materials are collected in western Lake Superior by the Bureau's research vessel Siscowet.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5B. FISH HABITATS

Physicochemical and Biological Properties; Effects of Environment. Including Pollution, on Fish.)

5.0185, PINK SALMON INVESTIGATIONS - FRESHWATER ECOLOGY

W.R. HEARD, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

Total freshwater mortality of pink salmon (Oncorhynchus gorbuscha) has been measured in Sashin Creek since 1940. For the average brood year, only 6 percent of the total eggs potentially available for deposition produce fry migrating to the estuary, but survival may vary between 0.2 and 23 percent. Since 1943, odd year runs have consistently produced a greater magnitude of spawners and higher freshwater survival than even year runs. Most mortality occurs between the time of egg deposition and fry emergence.

One of the goals of this research is to identify the factors causing mortality in spawning beds, determining which are density dependent and which are non-density dependent. Environmental factors including water flow and temperature, dissolved oxygen supply, gravel composition, permeability of the stream-bed, rates of oxygen removal due to decomposing organic matter and the mechanics and kinetics of spawningbed siltation, are studied in relation to mortality rates. Biological factors, including density, temporal and spatial distribution, fecundity and size of spawning adults are also measured in Sashin Creek and related to mortality rate.

Four experimental spawning channels in nearby Lovers Cove Creek provide similar natural environments where spawner density is controlled. Factors studied here, as related to spawner density, include distribution and other behavior patterns on the spawning beds, efficiency of egg deposition, egg retention and total freshwater mortality.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0186, PINK SALMON INVESTIGATIONS - INTERTIDAL ECOLOGY

J.H. HELLE, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

5. LIVING SYSTEMS (NON-HUMAN)

The life history and ecology of pink and chum salmon spawning in stream intertidal zones has been under study at Olsen Creek, Alaska since 1960. Olsen Creek is located in Prince William Sound where intertidal spawning by these two species is of major importance.

Research during the first four years was aimed at describing the physical changes which occur within the streambed during tide cycles; assessing the magnitude, timing, distribution and biological characteristics of spawners; and measuring rates of development and survival of eggs deposited in the various ecosystems of the intertidal zone.

On March 27, 1964, the Great Alaska Earthquake caused drastic changes in stream elevations in Prince William Sound through uplift or subsidence of large areas of land. Stream channels within the intertidal zone were most vulnerable to the effects of land changes associated with the earthquake. Olsen Creek was uplifted about four feet, resulting in a removal of 1/4 of a mile of stream channel from tidal influence and creating a new intertidal zone in a previously unexposed area.

Present research includes a continuation of the observations initiated during the first four years of study and an evaluation of the ecological changes brought about by the earthquake. In addition, laboratory research on the effects of salinity on the growth and survival of pink and chum salmon eggs and larvae is in progress.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0187, PINK SALMON INVESTIGATIONS - EARLY SEA LIFE OF SALMON

J.W. MARTIN, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

Studies of the early sea life of pink and chum salmon were initiated in Auke Bay in 1962; in lower Chatham Strait in 1963; and extended throughout southeast Alaska in 1964 and 1965 as part of the Bureau's long-range pink and chum salmon research program.

Operations are based from the 58-foot research vessel M/V Heron which makes 8 to 12 day cruises throughout southeast Alaska from May to September. The M/V Heron serves as a mother-ship for Blue Boat, a 20-foot high-speed reconnaissance-catcher and has a laboratory for processing biological specimens and instruments for monitoring the sea-surface environment. Blue Boat, is equipped with a bow steering station for observations and fishing with a 100-fathom small fish round haul net. It ranges through study areas at high speed, while Heron proceeds between stations.

Additional biological investigations include: investigation of the relation of sea temperatures to survival of salmon fry; studies of the effects of water temperature on growth of salmon by raising fry in controlled saltwater temperature tanks in the laboratory; and investigation of the life histories of parasites which infect juvenile pink salmon in the sea.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0188, PINK SALMON INVESTIGATIONS - FRESH-WATER ECOLOGY

W.J. MCNEIL, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

Total freshwater mortality of pink salmon (Oncorhynchus gorbuscha) has been measured in Sashin Creek since 1940. For the average brood year, only 6 percent of the total eggs potentially available for deposition produce fry migrating to the estuary, but survival may vary between 0.2 and 23 percent. Other studies have revealed that mortality occurs mostly between the time of egg deposition and fry emergence.

One goal of research conducted at Little Port Walter is to identify the factors causing mortality in spawning beds, determining which are density dependent and which are nondensity dependent. (Environmental factors including water flow and temperature, dissolved oxygen supply, and gravel composition and permeability are measured and related to mortality rate.) Biological factors, including density, temporal and spatial distribution, and size of spawning adults are also measured and related to mortality rate.

Another research goal is to develop a better understanding of the factors responsible for ecological change in spawning beds. In this regard, we are investigating rates of oxygen removal due to decomposing organic matter and the mechanics and kinetics of spawningbed siltation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0189, SILVER SALMON STUDIES IN THE RESURRECTION BAY AREA

S.M. LOGAN, State Dept. of Fish & Game, *Juneau, Alaska*

Objectives: (1) To collect and analyze biological data concerning the distribution, abundance and timing of adult and outmigrant silver salmon smolts in the Resurrection Bay area. (2) To determine the age composition of adult and juvenile silver salmon smolts. (3) To determine the sport harvest of silver salmon in Resurrection Bay and natural mortality in salt water. (4) To investigate the fresh water environmental limitations on juvenile silver salmon in this area. (5) To determine the methods and means of increasing or extending the fresh water spawning and rearing areas of the watershed and mitigating fresh water mortality. (6) To determine the reinfestation rate of non-salmon species in rehabilitated Bear Lake. (7) To provide recommendations for the management of silver salmon in these waters and direct the course of future studies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Alaska State Government

5.0190, INVESTIGATION OF SPAWNING GROUND POTENTIALS AND GROWTH AND SURVIVAL OF JUVENILE SOCKEYE SALMON IN FRAZER LAKE SYSTEM

W.R. MEEHAN, State Dept. of Fish & Game, *Juneau, Alaska*

The objectives of this phase of the project are:

1) To evaluate spawning ground potentials of Frazer Lake in terms of quantity and quality of available gravel.

2) To determine present utilization of spawning areas by tagging upstream-migrant sockeye adults at Dog Salmon weir, and observing their distribution on spawning tributaries of Frazer Lake.

3) To enumerate and sample downstream-migrant sockeye salmon to obtain data regarding age, size and timing of smolts in the system.

4) To obtain preliminary limnological information concerning productivity of the lake itself, in terms of physical characteristics and plankton abundance and distribution.

A weir will be installed in the Dog Salmon River (outlet of Frazer Lake) in early May 1965. Smolt sampling and enumeration will continue until the migration ceases.

Adult spawners will be enumerated and tagged as they enter the system, from early June through their migration, and spawning ground surveys will be made during July and August of 1965 to determine utilization of spawning areas and related factors.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0191, RESTORATION AND REHABILITATION OF EARTHQUAKE DAMAGED PINK AND CHUM SALMON STUDIES IN PRINCE WILLIAM SOUND

P.S. ROYS, State Dept. of Fish & Game, *Juneau, Alaska*

Major Overall Objectives: (1) Restoration of earthquake destroyed pink and chum runs in Prince William Sound. (2) Rehabilitation of spawning areas where production has been seriously curtailed.

Initial Objectives: (1) Biological and Engineering studies on 12 major streams in the subsided zone and 43 major streams in the uplifted zone. (2) Monitor streams to which restorative measures were applied during June 1067.

Procedures: (1) Engineering studies of priority streams to determine drainage area; maximum-minimum volumes of flow; flow velocities; bottom composition; bed load; contours; profiles; cross- sections; silt content; and rate of erosion followed by topographic mapping of study sections. (2) Biological studies of priority streams to determine spawning areas utilized by brood distribution within predetermined zones; measurements of spawning areas utilized; lost and gained; sex ratios; egg retention; scale samples; temperature; pH; subsequent egg deposition; and sequential fry production.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0192, MONITORING THE EFFECTS OF LAND USE ON SALMON PRODUCTION

T.C. HOFFMAN, State Div. of Comm. Fisheries, *Juneau, Alaska*

Objectives: To compliment and extend the presently established joint monitoring effort of the U.S. Forest Service and the Alaska Department of Fish and Game in order to determine if stream changes due to logging and other causes occurred and to what extent these changes effected the potential of these streams to produce salmon fry.

Characteristics Monitored: (1) Composition of streambed spawning areas. (2) Streamflow and water temperature. (3) Stream channel configuration and amount and kind of debris in the stream. (4) Classification of soil types in the watershed. (5) Sources of sediment. (6) Production of salmon fry and survival. (7) Assessment of adult salmon escapement.

Characteristics studied prior and subsequent to land use and observations taken yearly.

The studies to date have been a cooperative venture between the U.S. Forest Service and the Alaska Department of Fish and Game with each agency responsible for part of the work. The study is primarily to establish a base for management action and is presently being conducted in one important salmon producer in Southeastern Alaska and will be extended to three with special reference to logging and road building.

Procedures: For those characteristics monitored by the Alaska Department of Fish and Game as described in Fisheries Research Institute, University of Washington Field Manual dated 17 February 1964.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0193, THE ROLE OF THE SENORITA, OXYJULIS CALIFORNICA, AS A CLEANING ORGANISM

E.S. HOBSON, U.S. Dept. of Interior, Tiburon Marine Lab. , *Belvedere - Tiburon, California* 94920

In the investigation of this cleaner fish, an attempt is being made to assess its role in maintaining the health of inshore sport fishes. It has been widely contended that most of the better inshore fishing locations in southern California are, in fact, cleaning stations, where sport fishes, and other species, are concentrated to have extoparasites and diseased tissue removed by this cleaner. Our work is designed to better understand this phenomenon, and to evaluate its significance to the sport fishery.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0194, ECOLOGY OF THE KELP FORESTS

E.S. HOBSON, U.S. Dept. of Interior, Tiburon Marine Lab. , *Belvedere - Tiburon, California* 94920

This program attempts to determine relationships between sportfishes and their environment in this extremely important, but rapidly diminishing California marine habitat. Emphasis is on feeding and other aspects of behavior in relation to time of day and night.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0195, LIFE HISTORY OF BILLFISHES

G.B. TALBOT, U.S. Dept. of Interior, Tiburon Marine Lab. , *Belvedere - Tiburon, California* 94920

OBJECTIVE: To determine age, growth rate by sexes, food habits, spawning period and spawning location, and catch statistics of striped marlin and Pacific sailfish.

PROCEDURE: Biological data will be collected from sport catches at Mazatlan, Baja California, and southern California. Early life history data will be obtained from plankton samples and night lighting from oceanic cruises. Data on catches and catch per unit of effort will be obtained from resorts and charter boat operators.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0196, PELAGIC SHARKS OFF SOUTHERN CALIFORNIA

G.W. BANE, Univ. of California, Graduate School, *Irvine, California* 92664

This equipment will be utilized as the primary research vessel for a study of the pelagic sharks off Southern California. The objectives of this project are: the identification of those species found in this offshore region of the Northeast Pacific Ocean; the seasonal and annual population variations; and the environmental factors influencing the abundance and distribution of these pelagic species. Detailed life history studies will also be undertaken for the more prevalent sharks encountered.

As a personnel menance, sharks constitute a severe morale problem. By studying the fundamental factors that effect and/or govern the distribution of sharks and other animals, one can gain knowledge that can be used to develop more effective techniques and concepts of personnel protection.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0197, FISHERY FORECASTING - TEMPERATE FISHERIES

G.A. FLITTNER, U.S. Dept. of Interior, Fishery Oceanography Ctr. , *La Jolla, California*

This continuing project seeks to gain an understanding of the relation between fish stocks and their environment which will serve as a basis for predicting time and space fluctuations in the availability of fish resources.

Sea-surface temperature charts for the eastern Pacific have been issued monthly since January 1960 and 15-day charts for the region adjacent to the U.S. west coast have been issued from April through October every year since 1960. Source of the temperature data is the ESSA-Weather Bureau's marine synoptic weather observations collected from cooperating ships at sea; about 12,000 individual observations are obtained monthly. The charts have been highly successful and useful to tuna fishermen and to oceanographers and other marine scientists studying circulation features in the Pacific.

By-products of the weather summary program derived by using the computer at the University of California at San Diego, include the following: average sea temperatures (degrees F) by 2-degree squares; average sea temperatures (degrees C) by 5-degree squares; barometer averages (mb) by 1-degree squares; average meridional and zonal wind vectors (kts) by 1-degree squares; average wind velocity (kts) by 1- degree squares; and oceanic heat budget data (cal/sq cm/day) by 5 degree square.

The present system acquiring real-time oceanographic and meteorological data from other Federal agencies has worked well and we plan to improve this system further by use of automatic data processing equipment. Future plans are to extend the forecasting service to other fisheries in the temperate fisheries zone--the salmon trolling fishery off northern California and the wetfish fishery out of southern and central California ports.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0198, LOCAL FISHERY SYSTEMS DEVELOPMENT

F.H. HESTER, U.S. Dept. of Interior, Fishery Oceanography Ctr. , *La Jolla, California*

The purpose of this project is to identify and develop new or underutilized fishery resources in California. Presently underway is a new basking shark fishery for the extraction of squalene from their livers. Investigation is continuing of the pandalid shrimp resources of the continental slope and of the canyons across the continental shelf in southern California in cooperation with the California Department of Fish and Game. Also under investigation is the possibility of introducing the small floating longline for broadbill and other swordfish to the California fishery, presently worked by small harpoon boats.

5. LIVING SYSTEMS (NON-HUMAN)

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0199, SPORTFISH YIELD OF NATURAL REEFS

D.J. MILLER, State Dept. of Fish & Game, *Menlo Park, California*

Objectives: To determine the yield in numbers and by weight of all species of fish taken by sport fishermen from two heavily fished reefs in Monterey Bay. Additional data on the movement by species, time of year, and size of fish from these reefs to adjacent reefs will be gathered. Effects of kelp canopy removal on fish density and distribution will be determined on the Monterey Reef area.

Procedure: Reef yield procedures will include an intensive sport catch sampling program at Monterey and Capitola as well as tagging and trapping procedures on the reefs under study. The catches at these ports will be separated as to reef area of origin. Rewards will be given for fish returned with the tag intact. All species will be captured by hook-and-line or with traps using the project's 18-foot skiff. Scale samples will be taken from all fish released, for supplemental age and growth information.

Work Schedule: Effects of kelp canopy removal of giant kelp (Macrocystis) and bull kelp (Nereocystis) on resident fish populations (both juvenile and adult) will be determined on the reef area under study near Monterey. Underwater observations by SCUBA divers, photography, and trapping procedures will be used to determine density, distribution by species, and size of fish.

Comparisons of fish density-distribution will be made before and after cutting operations. Continued periodic observations will be made over several seasons in this experimental area.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
California State Government

5.0200, SCRIPPS TUNA OCEANOGRAPHY RESEARCH PROGRAM

M. BLACKBURN, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The Scripps Tuna Oceanography Research program has received practically all of its support from the Bureau of Commercial Fisheries through a continuing contract beginning in 1957. The purpose of this investigation is to increase the knowledge and understanding of physical, chemical, and biological conditions in the eastern tropical Pacific; to use this information to understand changes in availability of tuna in areas where a fishery now exists; and to identify areas into which the fishery for skipjack tuna might expand.

Since tuna spend their entire life on the high seas, their behavior is greatly influenced by changes in the oceanic environment. Research in this program, therefore, has centered on such subjects as the relation between tuna and temperature, between tuna and the distribution of their food organisms, primary production, and wind-caused upwelling. The STOR group has described and charted oceanographic properties and features of the eastern tropical Pacific which have been shown to be tuna-connected and has begun the charting of chemical nutrients and micronekton samples taken on the EASTROPAC expeditions (1967-68). Other accomploshments of the program in tuna ecology are as follows: Experimental studies on the effects of various physical and chemical conditions affecting the growth of phytoplankton, generalized summaries of oceanographic information of regions of present or potential tuna catch, analysis of time series of property measurements, studies of the El Nino current system, evaluation of galatheid crabs as a potential fishery resource, studies of the distribution of pelagic mysid shrimps, and food chain studies.

From the beginning of the program to the present time, STOR members have published 70 scientific papers; in addition 7 are in press or have been submitted for publication.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0201, LOCATION OF INSHORE SPAWNING AREAS

W.A. LUND, State Board of Fish. & Game, *Hartford, Connecticut*

Objective: To determine the location of inshore spawning areas.

Procedure: Ripe bluefish are found in Long Island Sound during the latter part of July, and the spawning area for these fish is not known. A concentrated plankton sampling program should determine whether bluefish spawn in the sounds off Connecticut.

The problem of ctenophores clogging the nets might not exist in future tows. If it does, samples can still be obtained in Block Island Sound and perhaps in the western end of Long Island Sound. Last year no attempt was made to sample these areas or to attempt to determine the extent of ctenophore abundance. A concentrated effort was made in the offshore area where positive results were being obtained.

It is proposed to begin sampling the inshore areas during the first week of July. Sampling will continue on a biweekly basis until bluefish larvae are obtained. Once positive evidence has been gathered, a concentrated effort will be made to determine the extent of inshore spawning. Samples will be taken, when possible, throughout Block Island and Long Island Sounds.

The nets to be used will be the type which have proved to be successful in catching larval bluefish in offshore waters.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Connecticut State Government

5.0202, POTENTIAL FISHERY FOR RIVER HERRINGS IN CONNECTICUT RIVER

W.A. LUND, State Board of Fish. & Game, *Hartford, Connecticut*

During 1966, basic information will be gathered on the time and duration of the run of each species of Alosa (with the exception of Alosa sapidissima) which enters the Connecticut River. Physical data will be gathered and temperature will be constantly monitored near the mouth of the river. The entering adults will be sampled with gill nets and lengths, weights and sex will be recorded. Scale samples will be taken for age determination. This sampling will continue periodically during the entire run. The techniques worked out and the basic data gathered at this time will be used to plan a more intensive study to be conducted in 1967 and 1968.

A survey will be made to ascertain the major spawning areas of each species. This area will be sampled with gill nets, seines and plankton nets to determine the species present and if spawning has occurred. Physical and chemical data will also be collected at this time.

This preliminary survey augmented by information gathered on the other sub-projects should enable us to design an intensive survey which will be carried out in 1967 and 1968.

The laboratory facilities of the University of Connecticut, Marine Research Laboratory will be utilized for this sub-project.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Connecticut State Government

5.0203, FARMINGTON RIVER SHAD STUDIES

W.R. WHITWORTH, Univ. of Connecticut, Agricultural Experiment Sta., *Storrs, Connecticut* 06268

Objective: To determine the ability of a section of the lower Farmington River (1) to provide a migration route for American shad and anadromous salmonids, and (2) to hatch and rear eggs and young of the above fishes.

Procedure: Various points will be periodically sampled for plankton, bottom fauna, fish (eggs, larvae, and adults), selected chemical and physical characteristics, and a water-sample taken back to the laboratory for routine bioassay. Data will be compared by analysis of variance and graphically.

SUPPORTED BY Connecticut State Government

5.0204, FEEDING HABITS OF ATLANTIC TUNAS AND NEKTON ECOLOGY

A. DRAGOVICH, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab., *Miami, Florida*

Objectives: 1. To investigate and describe the feeding habits of Atlantic tunas. 2. To describe the distribution of components of the nekton community of the tropical Atlantic upon which tunas prey. 3. To investigate and describe the dynamics of the tuna forage nekton community and the ecological relationships between these organisms and measurable environmental variables. 4. To investigate how environmental variables relate to, and have an effect upon the distribution of tuna forage nekton.

Once the important food species are identified, attempts will be made to sample them by an adequate sampler and synoptically observe environmental features. Through this synoptic approach the ecological relationships between the organisms and their environment will be studied and described.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0205, STRUCTURE OF THE FISH FAUNA OF A FLORIDA CORAL REEF

W.A. STARCK, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

The project involves three phases. The first is preparing maps of the topographic features and bottom types of the study area. The dominant sessile organisms associated with each bottom type will also be described. The second phase is a phylogenetic presentation of the fish species found in the area. Information on general behaviour, habitat, size, color pattern, feeding habits, nocturnal behaviour, and various other information when available will be given for each species. The third and final phase involves putting together information from the first and second phases. Various characters of the fish species involved will be related to the distribution of the species in the environment and will also be related to the presence or absence of other associated characters. This work is the culmination of eight years of past effort in the study area and varying portions of the three phases are already complete.

SUPPORTED BY U.S. National Science Foundation

5.0206, EFFECTS OF MARSH MANAGEMENT STRUCTURES UPON FISHES

W.G. PERRY, Rockefeller Wildlife Refuge, *Grand Chenier, Louisiana* 70643

More and more people are trying to get maximum yield from their lands. This has lead to gradual draining, channelization and drying of many acres of prime marsh land. It is a known fact that these estuaries are not only valuable for waterfowl but are important nursery areas for the bulk of our fish and shell fish. Three of the most commercially involved species are menhaden, shrimp and crabs. In order to slow down this steady draining of water from our marsh, various water management structures have been devised. Among the most common are dams, weirs, and controlled flow gates.

This project is intended in order to be able to better understand the effects of the continued use of these structures upon our fisheries.

SUPPORTED BY Louisiana State Government

5.0207, CHEMICAL AND PHYSICAL DATA

W.J. LORIO, State Wildlife & Fish Comm. , *New Orleans, Louisiana*

Objective: 1. To determine if any correlation exists between the abundance of various game fish populations and the salinity of the water. 2. To determine the abundance of fish present with relation to tides, turbidity and water temperatures.

Procedure: When fish populations are sampled, salinities will be taken with the aid of a field hydrometer kit. Other field chemistries will include determinations for carbon dioxide and carbonate and bicarbonate alkalinity. At the same time, secchi disc reading will be made at each station and a water sample collected to be read later using a Jackson Turbidimeter in the New Orleans Laboratory. Chloride determinations will be made. This procedure will be followed in each fish population sampling area. Tide direction will be noted and recorded at each sampling station.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Louisiana State Government

5.0208, ABUNDANCE AND AVAILABILITY OF PRE-RECRUIT HERRING

J.J. GRAHAM, U.S. Dept. of Interior, Biological Laboratory, *Boothbay Harbor, Maine* 04538

This project is concerned with the ecology of larval and juvenile herring, Clupea harengus (Linnaeus), in the coastal waters of the Gulf of Maine. The purpose of the study is to determine trends in the distribution and abundance of the early life history stages of herring and their relation to variations in the environments. Biological and physical observations are to be taken concurrently along the coast from Cape Ann to Grand Manan Island, and the Sheepscot-Boothbay Damariscotta region of Maine. Biological collections involve larvae, small fishes, adult fishes, and plankton. The corresponding collecting gears are Gulf III sampler, Boothbay Depressor trawls, and otter trawls. Physical measurements are to be made of temperature, salinity, transparency, and currents involving bathythermograph and Nansen bottle casts, photometer lowerings, and release of drift bottles and sea bed drifters. To ascertain the movements and migration of pre-recruit herring, exploratory cruises will include estuarine situations and some gear development will be undertaken for specialized sampling.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0209, THERMAL PREFERENCES OF MARINE FISHES AND INVERTEBRATES

D.W. BRIDGES, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

Introduce marine fishes and invertebrates into experimental aquaria or tanks having temperatures similar to the natural environment of the organisms. By altering substrates, lighting, etc., attempt to determine normal patterns of behavior and response in a particular temperature regime; compare the activity in experimental aquaria with that observed in the field. Then manipulate temperature so that vertical and horizontal gradients or thermal regimes are established; observe behavior which occurs concomitant with alteration of established temperature in order to determine if thermal preferences or optimal temperatures exist.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0210, EFFECTS OF HOT WATER MASSES ON MARINE FISHES

D.W. BRIDGES, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

After conditioning a group of fish to approach a feeding station on cue, introduce different hot water strata between the fish and the food source to determine the effect of water temperature on modifying their behavioral responses.

We will measure the rate of fish passage through heated water to determine at what level temperature may act as a barrier. Experimental animals will include forms commonly found in the Cape Cod area. Techniques will be developed which can be adapted to similar studies for evaluating effects of thermal effluents anticipated in other coastal areas.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0211, INFLUENCE OF THE PHYSICAL ENVIRONMENT ON DISTRIBUTION OF YOUNG STAGES OF COASTAL GAME FISH

R. STONE, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

The fate of critical young stages of coastal migratory fish is governed largely by conditions of the physical environment. Physical measurements of the continental shelf waters will be concurrent with the collection of ichthyoplankton (see 2541-01– in an attempt to relate the distribution of young stages of fish to physical conditions in the environment. Hydrographic stations will be made on each of eight cruises from Cape Cod, Mass., to Cape Lookout, N.C., along 14 transects. Observations will include temperature, salinity, oxygen content and turbidity. Drift bottles and bottom drifters will be released at each station.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

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5. LIVING SYSTEMS (NON-HUMAN)

5.0212, HYDROGRAPHY, SEDIMENTATION AND CHEMICAL ASPECTS OF THE REEF ENVIRONMENT

R.B. STONE, U.S. Dept. of Interior, Sandy Hook Marine Lab., *Highlands, New Jersey*

Measure selected parameters of the physical environment surrounding the reef materials to determine how these factors relate to the distribution of fish on the reef site. Divers will determine and record the following: speed and direction of current flow, rate of scouring or sedimentation, alignment and height of ripple marks, bottom type and water transparancy at surface and bottom. Standard shipboard methods for measurement of temperature and salinity will be used to determine vertical and horizontal gradients of temperature, salinity and density.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0213, ESTUARINE BIOLOGY--RESPONSE OF LARVAE TO TEMPERATURE AND SALINITY

R.M. LICHTENHEK, U.S. Dept. of Interior, Biological Laboratory, *Beaufort, North Carolina* 28516

Atlantic menhaden hatch in the ocean and migrate into shallow estuarine nursery areas as larvae. The effect of temperature and salinity on survival may be a determining factor in year class size. Field observations have shown that low temperatures delayed entry of larvae into the estuary from the ocean and after establishment in the nurseries, caused massive mortalities. Laboratory experiments were conducted to determine the lethal temperatures. Preliminary findings confirmed the field observations that 3 degrees Centigrade may be the lower limit at estuarine salinities.

Plans are underway to continue the laboratory work when larvae become available in January 1964. Methods consist of holding larvae at various temperatures and salinities, with and without acclimatization to lower temperatures, to determine the lethal limit of chilling.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0214, ROUTINE SAMPLING AT SEVEN INDEX STATIONS

V.C. APPLEGATE, U.S. Dept. of Interior, Biological Station, *Sandusky, Ohio*

Early work conducted by the R/V Cisco in Lake Erie in 1957 indicated the desirability of establishing regular sampling stations in the western basin of the lake for collecting both fishery and limnological data. Relatively rapid changes in both the environment and the fisheries that were known to be occurring could only be identified and defined on a long-term basis by such a program.

In 1958 and 1959, seven stations in the western end of the lake were visited in the spring, summer, and fall. Since 1960, only the summer visit to each station has been made due to limitations of funds, personnel, and equipment.

At each visit to each station, physical and chemical limnological data and plankton and bottom samples are collected by conventional procedures. Larger fish are collected by trawling and fry are sought with tow nets. Limnological data and plankton and bottom samples are turned over to the Biological Laboratory's Environmental Research Unit for analysis. Fish and fry collections are retained at the Sandusky Biological Station for current and future studies. Ultimately, all fishery and limnological data will be integrated by the two groups to demonstrate relationships that may exist between them.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0215, EVALUATION OF ESCAPEMENT OF ADULT SALMON TO OREGON COASTAL STREAMS

D.G. SKEESICK, State Fish Commission, *Charleston, Oregon* 97420

Numbers of chinook, coho and chum salmon in spawning runs in Oregon coastal streams are counted at times of peak of activity in standard survey units to record trends of abundance of these salmon. Analysis of this information is expected to show relations of biological and environmental factors to numbers of spawning fish in these streams.

SUPPORTED BY Oregon State Government

5.0216, ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON

H.F. HORTON, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

The first objective of this project is to provide fundamental understanding of the ecological factors which influence the abundance and well being of the recreationally important fish species in Oregon estuaries. The second objective is to develop the understanding of the ecology of the various species into recommendations for management practices for the conservation of populations of estuarine fishes. Immediate objectives are: (1) To study the movements and migrations of Oregon's estuarine fishes in relation to the factors of their environment. (2) To estimate the periodic abundance and angler yield of the various populations of estuarine fishes. (3) To study the growth and mortality factors which may influence the maintenance of populations of estuarine fishes.

Intra-estuarine and coastal movements of the recreationally important fishes will be determined by the analysis of recoveries of tagged specimens. Estimates of population size and angler yield will be determined by use of the capture-mark-release-and-recapture technique. Growth rates will be determined by scale analysis, length- frequency distributions and empirical data on length recorded at periodic intervals. Mortality factors will be determined by fecundity, longevity and angler yield data. Environmental factors as temperature, salinity, tidal cycle and associated fauna will be recorded and related to the factors listed above. Based on the relationships developed, recommendations for management will be made.

SUPPORTED BY Oregon State Government

5.0217, INVENTORY SURVEYS OF OREGON COASTAL STREAMS

R.E. LOEFFEL, State Fish Commission, *Salem, Oregon*

Purpose: To assess the value of streams for spawning and rearing of salmon and to locate fish passage obstructions.

Methods: Salmon and steelhead habitat are evaluated on coastal river systems. Records are kept of bottom composition, obstructions, observations of fish, condition of the watershed and accessibility.

Results: Approximately 2,600 miles of coastal streams have been surveyed. These surveys have provided information for stream clearance, laddering projects and planting fish.

Reports: Unpublished reports prepared and maintained on file.

SUPPORTED BY Oregon State Government

5.0218, SPRING CHINOOK SALMON ECOLOGY STUDY

A.L. OAKLEY, State Fish Commission, *Salem, Oregon*

Purpose: To study production and ecology of spring chinook salmon in an eastern Oregon stream.

Methods: Trap and enumerate upstream-migrating adult spawners and downstream-migrating juveniles to measure production. Monitor physical factors affecting production. Study behavioral activities of juvenile chinook at various stages of development in their natural environment.

Results: Trapping facilities have been constructed for capturing upstream and downstream migrants. A detailed inventory of the physical environment was accomplished for each 100-foot section in 15 miles of the study stream. Downstream-migrating juvenile salmonids have been marked for recapture at locations below the trapping facilities. The efficiency of the downstream-migrant trap is being evaluated at various stream flows by marking the fish at the trap and recapturing them after release upstream. Length and weight data were obtained from juveniles collected in the study stream by seining and electro-fishing. Spawning ground surveys are conducted annually to determine potential egg deposition and the relationship of physical factors to choice of spawning locations.

Reports: Annual Progress Reports.

SUPPORTED BY Oregon State Government

5.0219, MEASUREMENT OF BIOLOGICAL FACTORS OF VARIOUS HABITATS, AND THEIR RELATION TO THE BIOLOGY OF THE COMMERCIALLY IMPORTANT SPECIES

A.E. DAMMANN, Virgin Isls. Off. of The Gov. , *Saint Thomas - Charlotte Amal. , Virgin Islands*

Phase 02: Particulate matter from water samples at each station will be collected by filtration and centrifugation. Chlorophyll content of a given water volume will be determined, and incubation techniques, using C14 tags, will help determine the basic productivity at each station. Planktonic organisms will be preserved and preliminary analysis undertaken. Extensive analysis will have to await the attention of specialists at some later date. It is hoped that a relationship between physical-chemical and biological properties of water samples from the various stations can be demonstrated and related to fin fish and shellfish populations.

Arthur E. Dammann and personnel to be hired or used on a collaborative basis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Virgin Islands Government

5.0220, STREAM IMPROVEMENT PLANNING

R. KRAMER, State Dept. of Fisheries, *Olympia, Washington*

OBJECTIVES: It will be the objective to catalogue river and stream obstruction which prohibit full utilization of upstream by anadromous fish. To detail site correction procedures and provide benefit-cost reports concerning feasibility of undertaking specific improvement projects.

LOCATION: Various streams in Western Washington exclusive of the Columbia River watershed, per listing provided in proposal.

WORK PLANNED: 1. Stream and river obstructions will be appraised and catalogued through the means of on site inspections. 2. Various seasonal stream flow data, photographs and necessary elevations and measurements will be utilized to provide criteria on which specific correction planning and design can proceed. 3. Biological reports will be prepared concerning species of fish to be benefited and quantities of naturally produced fish to be realized through improvements. 4. Benefit-cost evaluations will be conducted for each site. 5. Site access problems will be defined and preliminary site and functional sketches of required improvements will be provided for those sites where improvement work is recommended.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5.0221, EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS

W.J. EBEL, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

Supersaturation of dissolved nitrogen in the Columbia River can be a significant factor in the survival of migrating salmonids. Measurements of nitrogen levels from the estuary to the upper Columbia River have indicated that highest levels were reached in the spring when large volumes of water were being spilled at dams. Nitrogen concentrations, which were sufficiently high to produce gas bubble disease in fish, did not equilibrate in reservoirs between dams. Migrant salmonids using fishways or passing through shallow areas that force them near the surface may suffer mortality from high nitrogen levels.

In conjunction with current fish behavior studies on the Columbia River, experiments are in progres to examine the effect of nitrogen levels on survival of migrating adult salmonids. Salmon in fishways are being inspected for evidnece of gas bubble disease, and systematic searches of the river system are being made to obtain samples of moribund fish for clinical examination. Laboratory experiments are planned to determine the effects of nitrogen saturation at different pressures and temperatures on survival of young and adult salmon.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0222, RELATION OF RIVER-RUN IMPOUNDMENTS TO SALMON PRODUCTION

A.J. NOVOTNY, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

This program seeks to develop a self-sustained, mobile field laboratory, designed for maximum flexibility, which will provide a working base for unlimited aquatic environmental studies in navigable impoundments, and eventually in marine bays and estuaries. Primary emphasis is being placed on studies related to changes in the environment induced directly or indirectly by human activities and the effects of these environmental changes on salmon. These studies will include on-site experimental control of water quality to determine the feasibility of 'carrying' salmon through critical phases of their life cycle in river-run impoundments. Parameters of control include temperature, filtration, sterilization, dissolved gases, and waste products.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0223, JUVENILE MIGRATION RATES

H.L. RAYMOND, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

This project is aimed at assessing the effects of dams and impoundments on the timing and survival of juvenile salmonids migrating to the sea. Extensive marking of fish is being done in tributary streams of the Columbia and Snake Rivers, using thermal brands. Recovery of marked fish from turbine intake gatewells at dams in the Columbia and Snake Rivers and from the estuary by purse seines and beach seines is providing data on rates of movement, timing of migration, and survival of young fish in relation to the changing environment.

Information being gathered will be used to identify areas in which delays and mortalities are occurring as the result of environmental changes. These findings would then be applied to implement management practices designed to enhance survival of seaward migrating salmonids.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0224, SALMON PRODUCTION IN AREAS MADE INACCESSIBLE BY DAMS

G.R. SNYDER, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

Researchers will assess available spawning and rearing areas, condition of gravels, productive capacity of lakes and reservoirs, availability of re-seeding stock with desired racial characteristics, existing predator-competitor species, and demonstrate productive potential experimentally.

Prospects for successful reestablishment of salmon runs in areas blockaded by dams are to be evaluated in the light of expanding Indian fisheries and industrial developments in the Columbia Basin.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0225, PREDICTION OF ENVIRONMENT

G.R. SNYDER, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

A chain of reservoirs is rapidly replacing the remaining free flowing areas of the Columbia and Snake Rivers. Freshets and floods which played a major role in the transport of fingerling salmonids to the sea are being controlled. Temperature regimes that govern rates of growth and maturation are being modified, and in the changed environment, new predator-competitor and disease relationships are being established that greatly affect the survival of the migrant salmon. Studies are in progress to predict future environments in rivers and reservoirs. Work is nearing completion on the prediction of the physical and biological environment of John Day Reservoir in the Columbia River.

Studies are under way and planned to determine the feasibility of lowering water temperatures in the Upper Columbia and Middle Snake Rivers by tapping cool waters at the bottom of lakes and reservoirs. If thermal controls carry into downstream areas of these rivers, environmental conditions for survival of salmon could be measurably improved during the hot summer months. Potential benefits from timed releases of stored waters also are being evaluated in the light of proposed thermal-nuclear power developments in the Columbia Basin.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0226, EFFECTS OF INDUSTRIAL EXPANSION ON THE AQUATIC ENVIRONMENT OF ESTUARINE AREAS

G.R. SNYDER, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

The Lower Columbia River and its estuary plays a critical role in the life cycle of anadromous salmonids. Each year millions of young fish move downstream from native rearing areas and artificial propagation facilities. These fish all pass through the lower river and estuary where they undergo physiological transformations in preparation for their movement from fresh to salt water. The estuary also is an important nursery area and the transition zone for marine species of fish.

Industrial expansion in this area by the thermal electric power, aluminum, and pulp and paper industries can drastically modify the environment. Forecasts indicate that over 2000 MW. of electricity (possibly 4000MW.) could be produced in the Columbia estuary by 1985. The effects of waste heat discharged from these plants could be detrimental to the overall aquatic ecology and specifically to the production of commercial species of fish. Limnological studies are planned to determine the existing ecology at sites known to have potential for industrial expansion. The effects of increases in water temperature on aquatic organisms at specific sites will be studied. Predictions of physical and biological changes will be made. The effects of the environmental changes on fish and on secondary organisms necessary for their survival and growth will receive initial emphasis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0227, WATER QUALITY AS RELATED TO SURVIVAL OF SALMON EGGS AND LARVAE

D.E. BEVAN, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

One of the major uses of water resources in the Pacific Northwest is the reproduction of salmonid fishes. Previous work has shown that water quality is of major importance in the success of salmon reproduction. The project will investigate the suitability of spawning areas in the Snohomish River drainage and measure the mortalities of eggs and larvae. Observations will be made to relate other uses of the water resource to water quality and water quality changes will be directly related to salmon embryo mortality. Water quality will be measured both in the stream flow and the sub-surface flows within the gravel by observing flow rate, oxygen content, pH, alkalinity, and the presence or absence of some of the more common insecticides.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Washington

5.0228, STUDIES OF SOCKEYE SALMON, ONCORHYNCHUS NERKA, IN THE NUSHAGAK DISTRICT, ALASKA

R.L. BURGNER, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The project is a long-range comparative study of the sockeye producing lake systems in the Nushagak District of Bristol Bay in Southwestern Alaska. Studies are made of the spawning and nursery area capacities of the lakes, the growth, abuandance and survival of young salmon in relation to parent population density, the ecological and interspecific relationships, and the limnology and food chain dynamics of the lake systems. Effects of the selective commercial gill net fishery on the salmon population dynamics are also under study.

SUPPORTED BY University of Washington
U.S. Dept. of Interior - Bu. Comm. Fish.
Association of Pacific Fisheries

5.0229, MEASUREMENT OF SPAWNING SUCCESS AND FRY QUALITY OF CHUM SALMON UTILIZING A SPAWNING CHANNEL AT BIG BEEF CREEK, WASHINGTON

E.O. SALO, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The proposed work will include the improvement of the existing spawning channel, dikes, ponds and laboratory. The improvements include (1) additions to the walls of the channel, (2) addition of selected gravel, (3) reinforcement of dikes, (4) improvement of instrumentations and techniques in the laboratory for the measurement of fry and fingerling quality.

The schedule calls for the channel and ponds to be completed by August 1, 1968 to accommodate the early spawners. The work will be contracted. The location is the same as described in the original proposal. Principal and co-investigator are (1) Professor Ernest O. Salo and, (2) Predoctoral Associate, K. Victor Koski. Additional biologists include one Master of Schience candidate.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5C. FISH PHYSIOLOGY-BIOCHEMISTRY

5.0230, DIURNAL-NOCTURNAL ACTIVITY OF THE QUEENFISH, SERIPHUS POLITUS

E.S. HOBSON, U.S. Dept. of Interior, Tiburon Marine Lab. , *Belvedere - Tiburon, California* 94920

The habits of this croaker provide insight into factors influencing schooling, vocalizing and other behavioral characteristics of inshore fishes. Work is limited to the months May-September, when this fish is present inshore. During this period underwater observations made at all hours of day and night, along with analysis of digestive-tract contents and recordings of vocalizations by the croaker and incident- light measurements provide the data upon which this study is based.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0231, MOTIVATIONAL ANALYSIS OF COURTSHIP BEHAVIOR

G.W. BARLOW, Univ. of California, Graduate School, *Berkeley, California* 94720

This grant is for the continuation of studies conducted under GB-5314. For the past decade, the investigaror has been interested in the behavior of the cichlid fish, with the general approach being ethological in nature. An important part of the present proposal is to analyze aggressive, and courtship behavior in this species. An interrelationship between the two behavior patterns is noted in that aggressive behavior of the male toward the female first takes place followed by courtship and mating. Animated models will be used, with early work devoted to an examination of the role of basic variables involved in the presentation of the model itself. Subsequent studies will examine those stimulus conditions which influence aggressive as well as courtship behavior. Physiological indices, i.e., tissue changes found in the gonads and pituitary, will be correlated with behavioral changes.

SUPPORTED BY U.S. National Science Foundation

5.0232, EXPERIMENTAL STUDIES OF BEHAVIOR IN A CICHLID FISH

G.W. BARLOW, Univ. of California, Graduate School, *Berkeley, California* 94720

Brief Description of Research Project: This grant is for the continuation of studies conducted under GB-2210 at the University of Illinois.

Cichlid fishes are ideally suited for studies relating sexual and parental behavior. Pair bonds persist, facilitating joint parental care. The female may be active in courtship, permitting a precise comparison of male and female behavior. Furthermore, cichlid fishes have relatively indeterminate growth. Sexually mature animals are thus available over a wide size range (up to four fold in weight in the orange chromide), affording a unique opportunity to separate the influences of sex and size (dominance).

Under the current grant some information will be sought to clarify earlier findings on the effect of size on courtship, using artificial fishes to determine the specific parameters involved. Particular attention will be directed toward the parental phase. Egg-fanning will be resolved into its components and related to hostile, digging, and retrieving activities. To facilitate the analysis of retrieving, bubbles will be substituted for the eggs and larvae. The bubble carrying response will also be investigated to clarify the role of experience in developing the response, and to analyze the build-up and decay of a partially inborn response to a stimulus to which the fish do not habituate.

SUPPORTED BY U.S. National Science Foundation

5.0233, FUNCTION OF THE INTERRENAL GLAND IN TELEOST FISHES

H.A. BERN, Univ. of California, Graduate School, *Berkeley, California* 94720

This study is a continuation of work on the pituitary-interrenal axis of Tilapia mossambica and its regulation to osmoregulation. The effects of various experimental manipulations on quantitative and qualitative aspects of in vitro corticosteroid production by the interrenal-containing head kidneys of Tilapia are being studied, this work being directed toward eventual utilization of in vitro secretion as an index of in vivo interrenal activity. Analyses of corticosteroids in Tilapia plasma and of possible steroidal secretory products of the Stannius corpuscles are also being carried out.

Morphologic responses of interrenal, adenohypophysis and Stannius corpuscles to changes in environmental salinities and other conditions are being investigated, using mean nuclear diameter as an index of activity. Osmoregulatory responses of Tilapia to hormone administration or deprivation are also under study. The effects of prolactin and of hypophysectomy on osmolality of Tilapia plasma under conditions of osmotic stress are being examined, and parallel experiments using interrenal hormones or ACTH alone and in combination with prolactin are being undertaken.

Comparative studies in these areas are being conducted on other teleosts. In particular, analysis of steroids and measurements of interrenal and adenohypophysial activity in relation to environmental salinity are being carried out in Mugil species at the Stazione Zoologica of Naples.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0234, CELL TRANSFORMATIONS, DIVISION, AND MOTION

D. MAZIA, Univ. of California, Graduate School, *Berkeley, California* 94720

In summarizing this program by 3 faculty members and 27 predoctoral and postdoctoral associates, only the main lines of study can be indicated. These are (1) the investigation of the subunits of microtubules and their assembly; (2) the interaction of colchicine and other antimitotic agents with structure proteins; (3) the structure proteins of motile systems other than cilia and the mitotic apparatus, especially ameboid systems; (4) the active role of surface processes in cell association in very early development; (5) nucleoproteins as primers for nuclear DNA polymerase; (6) characterization of an RNA that turns over rapidly in the nuclei of sea urchin embryos during early development; (7) structure of chromatin in sea urchin embryos; (8) the role of cell interaction in the control of hemoglobin synthesis in the chick; (9) the regulation of d-amino levulinic acid synthetase in the activity of the chick embryo; (10) biochemical changes accompanying muscle cell fusion and differentiation, including studies of (a) synthesis of myosin, (b) synthesis of DNA, (c) levels of DNA polymerase, (d) levels of RNA synthesis.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0235, EXPERIMENTAL ANALYSIS OF HEARING AND ACOUSTIC ORIENTATION IN SHARKS

D.R. NELSON, Calif. State College, Graduate School, *Long Beach, California* 90804

The objectives of this project are the determination of hearing thresholds in sharks and the accuracy of directional hearing at different frequencies, as well an an experimental analysis of the parameters and receptive system employed in this directional hearing. Precise acoustic pressure and displacement measurements will be utilized in conjunction with conditioned response methods in both the laboratory and field portions of these studies. The natural behavioral patterns of unconfined sharks in their responses to sounds will also be investigated by means of a field playback and observation system, and related to the controlled laboratory segments of the project.

Knowledge of the environmental clues perceived by and used by marine animals in their orientation, food and mate hunting, and obstacle or enemy avoidance can provide valuable information of use in Naval operations. Additionally, in order to develop an effective shark repellent and in order to develop survival techniques for protection in shark infested waters, it is necessary to learn as much as possible about the factors in the sharks' environment to which it responds.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0236, GERMFREE FISH

M.D. APPLEMAN, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007 (NONR)

The objectives of this work are the maintenance and expansion of transient germ-free colonies of tropical fish Xiphorphorous helleri, and the possible establishment of a permanent colony. Investigation of physiological, anatomical, and immunological characteristics of the germfree vs. the conventionally reared fish will be continued. Determination of specific modes of microbial pathogenesis by selective contamination of the germfree environment will be sought.

This research in marine host-parasite relationships will increase our knowledge of the anatomical, physiological, and immunological responses of poikilothermic animals, contribute to our basic knowledge on (1) the effect of the germfree state on the individual animal as well as the group of animals and (2) the possible role of marine vertebrates as vectors in the transmission of human parasites.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0237, STUDIES IN THE PHYSIOLOGY AND BIOCHEMISTRY OF DEEP-SEA FISHES

M.S. GORDON, Univ. of California, Graduate School, *Los Angeles - U.C.L.A., California* 90024

The question under study is: What is the nature of the effects of high hydrostatic pressures, such as occur in the deep oceans, on the metabolism of deep-sea, as compared with shallow-water, marine fishes? Deep-sea fishes are hard to keep alive, hence work is presently centered on tissue studies -- primarily muscles and liver. Measurements of oxygen consumption are being made on tissue preparations from a wide range of warm and cool water shallow-water species, and on a number of mesopelagic species. These measurements take into account interactions between several factors: hydrostatic pressure (to 800 atmospheres), temperature, phylogenetic position of species, body size, activity patterns of species, environment of species. The project has required development of new equipment for high pressure respirometry.

SUPPORTED BY U.S. National Science Foundation

5.0238, VISUAL PROJECTION IN SUBMAMMALIAN VERTEBRATES

L. KRUGER, Univ. of California, School of Medicine, *Los Angeles - U.C.L.A., California* 90024

The organization of the retinal projection in a variety of vertebrates is being explored in topographic terms. Studies in several simple and specialized teleosts have been completed as well as in one species of reptile. Current investigations are concerned with properties of single units in the reptilian optic tectum. Parallel studies have been initiated for comparing the superior colliculus of mammals, and to date, studies of the rat colliculus and pretectal group have been completed. Current emphasis is being placed on the binocular projection in the primate colliculus.

Microscopic studies of the visual pathway are being pursued along two lines. One series of experiments deals with axonal degeneration with silver and electron microscopic methods. This study establishes conclusively the purely afferent nature of the reptilian optic nerve. Other studies involve autoradiographic techniques employing thymidine- H3 in regenerating optic pathways of teleosts.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0239, BLOOD CHEMISTRY OF FISHES

M.R. URIST, Univ. of California, School of Medicine, *Los Angeles - U.C.L.A.*, *California* 90024

Investigations will continue into the skeleton and body fluids of the Elasmobranchii with special attention being given to species taken in deep water of 200 to 600 fathoms. Analyses of the serums of cyclostomes and teleosts taken in the same locations in deep water will be made for controls. By use of X-ray and flourescent examination techniques, research will be conducted on the secretion of enamel and the basic biology of vertebral formation in deep water sharks, as well as the morphology and identification of different types of vertebra. Complementary studies will be continued on tissue transplants and bone repair in sharks, as well as blood calcium studies in cyclostomes, sharks, and boney fishes.

This is part of the program in Hydrobiology concerned with the adaptations of marine organisms to life in the sea. Navel problems caused directly or indirectly by biological organisms, such as fouling forms, sonic forms, and other pests, require for their solution a thorough knowledge of the natural conditions of life of the organisms necessarily acquired for life in the sea.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0240, BIOLOGICAL TRANSPORT OF GASES AND OTHER SUBSTANCES

T. ENNS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

Transport of dissolved CO2 and bicarbonate ions in cells and across cell membranes, particularily the facilitation of such transport by carbonic anhydrase, is being measured. Studies are being extended from mammalian red cells to other animal and plant cells. In vitro studies of the carbonic anhydrase facilitation of CO2 transport are also being conducted.

Relative renal excretion patterns of urea, creatinine, water and electrolytes in kidneys of elasmobranch fishes are being obtained. These will yield new information regarding the renal handling of urea. This will be correlated with the handling of CO2 and bicarbonate ions in an attempt to examine the possible role of carbonic anhydrase in kidney function.

Transport of labeled water, electrolytes, and other substances across the gills of elasmobranch and teleost fishes is being studied. The data will be compared with those obtained in mammalian lungs by the same methods.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0241, PHYSIOLOGICAL STUDIES ON FISHES LACKING HEMOGLOBIN

E.A. HEMMINGSEN, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The University of California, San Diego, proposes to continue investigating the physical adaptation of animals inhabiting polar regions by extending studies begun under GA-272 at McMurdo Station, Ross Sea, to the region about Palmer Station, Antaractic Peninsula.

The work involves catching fish of the family Chaenichthyidae which are characterized by an absence of hemoglobin for live specimens which will be needed in laboratory experiments to be conducted in the biolaboratory at Palmer Station. Experiments include metabolic and respiratory studies to determine the oxygen consumption in terms of environmental oxygen tension and termperature. Attention will be given to the efficiency of the gills and importance of cutaneous respiration. The oxygen-carrying capability of the circulatory system will be assessed by measurements of arterial and venous oxygen tensions of blood volume, heart rate and capillarization of skin and tissue. Comparative measurements will be carried out on other fishes possessing hemoglobin.

The field work will be completed at Palmer Station during austral 1967-68 by the principal investigator and one assistant. Assistance of USCGC Southwind's small boat in fishing operations is required. Laboratory facilities at the station are suitable to the experimental requirements of this proposal.

SUPPORTED BY U.S. National Science Foundation

5.0242, CYTOTAXONOMIC STUDIES OF TELEOST FISHES

A.W. EBELING, Univ. of California, Graduate School, *Santa Barbara, California* 93018

This investigation is for continuation of the research initiated under NSF grant GB-4277 for studies on the cytotaxonomy of deep-sea fishes.

Recent comparative studies of shallow marine and freshwater fishes have strengthened hypotheses to be further tested during the proposed investigation: that even closely related teleosts are karyotypically distinguishable both numerically and morphologically; that most diploid numbers approximate or equal 48 with lesser numbers being the more specialized; that cytologically expressed heterogamety is widespread among teleosts and is especially prominant in deep-sea species; and that deep-sea fishes have longer, more heterochromatinized chromosomes, possibly relating to decelerated mitosis and therefore an 'economy of life' in the cold, impoverished depths. Also, as time permits, special studies of cytological sex heteromorphy in the genetically well known freshwater cyprinodontiform minnows will broaden the more general investigations of teleost heterogamety.

Generally, the aceto-orcein method of squashing hyptonically pretreated colchicinized tissues will be continued in observing karotypes of additional deep and shallow species and of the female tissues neglected in the previous investigation. Tissues other than gonadal will be more intensively treated, staining techniques will be expanded, and live specimens will be variously colchicinized. Tissue- culture of blood cells will be included in the regular program. Also, densitometric measurements of nuclear DNA content will be made of selected deep-sea fishes and their conordinal shallow relatives.

SUPPORTED BY U.S. National Science Foundation

5.0243, PARASITISM IN DEEPSEA FISHES

E.R. NOBLE, Univ. of California, Graduate School, *Santa Barbara, California* 93018

The aim is to characterize parasitism in a deepsea environment thru a study of a few species of fishes selected from the several faunistically distinct zones. Three hundred and thirty five hosts were examined, mostly from the mesopelagic zone. The midwater fishes have fewer parasites than epipelagic and bathypelagic species. The most common parasites are larval nematodes, and most of the protozoa (predominantly Myxosporida in the gall bladder) are found in bathypelagic fishes. Very few adult helminths are present, and most of these are hemiurid trematodies. In addition to Myxosporida the only other protozoa seen were Cryptobia in the stomachs of 4 species of hosts, and Trichodina in the stomachs of 1 species of host. The primary parasitological function of mesopelagic fishes appears to be for vertical transport of larval helminths to and from the upper pelagic and lower bathypelagic zones. The distribution of hosts and parasites is apparently indepedent but is influenced by the characteristics of the water masses in which they are found.

SUPPORTED BY U.S. National Science Foundation

5.0244, REPRODUCTIVE ISOLATING MECHANISMS IN PANAMANIAN INSHORE MARINE FISHES

I. RUBINOFF, Smithsonian Institution, *Balboa Heights, Canal Zone*

Pairs of closely related species of fishes occur in Panama separated by the Isthmus. The ancestral populations have been separated only since emergence of the Isthmus probably in the Pliocene. This project is designed to investigate the reproductive isolating mechanisms that have evolved since this separation. The ecology and behavior of the fish is being observed in nature. Reproductive behavior is being observed in the laboratory and tests of interbreeding potentials of species pairs are being made. Artificial hybridization will be attempted in all pairs.

SUPPORTED BY Smithsonian Institution

5.0245, STUDY OF THE RIVER PHASE OF THE LIFE HISTORIES OF ALOSA PSEUDOHARENGUS AND AESTIVALIS

W.A. LUND, State Board of Fish. & Game, *Hartford, Connecticut*

To study the life histories of Alosa pseudoharengus and aestivalis under the most ideal field conditions available and then utilize the results in large river systems, like the Connecticut River, where an intensive study such as this would be extremely difficult to do.

In general, it is proposed to construct a weir at a narrow section of the brook to obtain: a. The range in temperature when the fish enter the stream. b. The size composition, sex ratio and age structure of the entering groups. c. The effects of illumination on the movements of the fish to the spawning grounds. d. An estimate of the total numbers of fish entering the brook. e. An estimate of the total numbers of fertilized eggs which might be produced. f. An estimate of the mortality rate of adults on the spawning grounds by estimating the total number of fish returning to the sea. g. Fish for marking. The objectives of the mark are: 1. To establish whether it is possible to estimate total numbers of fish on the spawning grounds by a mark and recapture study. 2. To determine length of time fish remain on the spawning grounds. 3. To determine the degree of homing, and 4. if a high degree of homing is found, estimate the mortality at sea.

Part 2 o 2.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Connecticut State Government

5.0246, STUDIES OF FISH ENDOCRINOLOGY

G.E. PICKFORD, Yale University, Graduate School, *New Haven, Connecticut* 06520

The objectives of this research are to enlarge our knowledge of endocrinological functions in the euryhaline teleost, Fundulus heteroclitus. Specific attention will be paid to the role of hormones in fresh-water adaptation, with special reference to the regulation of the blood; the regulation of thyroid function and characterization of the teleostean thyrotrophin; the separation and characterization of the teleostean growth hormone (in collaboration with Dr. A. E. Wilhelmi, Emory University); hormonal stimulation of the regressed testes of hypophysectomized fish and the nature of teleostean gonadotrophin(s); and a study of hormonal mechanisms regulating the stress response to cold shock.

SUPPORTED BY U.S. National Science Foundation

5.0247, EVOLUTION OF ALL-FEMALE FISHES

R.J. SCHULTZ, Univ. of Connecticut, Graduate School, *Storrs, Connecticut* 06268

The genus Poeciliopsis, a viviparous fish found along the Pacific slope of Mexico, is made up of approximately 16 species. In addition to these, there are 5 forms of Poeciliopsis that give birth to exclusively female progeny. These all-female 'species' do not reproduce without benefit of males but must rely on other species for fertilization. The mode of reproduction and the appearance of the offspring depends upon the species that provided the sperm. In some cases the young are identical to the mother suggesting that the sperm merely served as a stimulus to embryonic development; in others, the progeny share characteristics of both parents and are true hybrids. All five forms are believed to have arisen through hybridization. It is the purpose of this investigation to determine the evolutionary pathway of these all-female fishes and to verify it by laboratory synthesis.

SUPPORTED BY U.S. National Science Foundation

5.0248, MARINE SPORTS FISHES RESEARCH

F.C. DAIBER, Univ. of Delaware, Graduate School, *Newark, Delaware* 19711

This project has been divided into different parts which include studies on the effects of temperature and salinity on the striped killifish, an analysis of the fish populations in Delaware Bay and an analysis of the hogchoker population in Delaware Bay.

The general objectives of the study on the striped killifish, Fundulus majalis, are to determine the salinity death point at high and low temperatures; to observe egg hatching time under varying temperatures and salinity conditions; to study the food intake; and to study the growth rate. The data is incomplete but there is evidence that this animal has a wide tolerance to temperature and salinity conditions.

Length-frequency distributions have been determined for the hogchoker, Trinectes maculatus, and other teleost fishes in Delaware Bay. Species, areas of concentration, variations in abundance as influenced by depth, salinity and season were recorded for different sectors of Delaware Bay.

SUPPORTED BY Delaware State Government

5.0249, OSMOTIC COMPONENTS IN ELASMOBRANCH BLOOD

K.S. PRICE, Univ. of Delaware, Graduate School, *Newark, Delaware* 19711

Levels of the major osmotic components (urea and sodium chloride) in elasmobranch blood are being determined from specimens collected from the lower Delaware Bay region. Samples will be collected in the field from fish taken from waters of naturally varying salinity over the entire range of salinity and temperature that the particular species normally experiences. Additional specimens are being subjected to controlled salinity and temperature conditions in the laboratory in order to determine the changes which occur in plasma levels of the major osmotic components due to 1) changes in external salinity and 2) changes in water temperature.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0250, BIOLOGY, MORPHOLOGY, AND EVOLUTION OF THE DISK-FISHES OR SHARKSUCKERS

E.H. LACHNER, Smithsonian Institution, *Washington, District of Columbia* 20560

The objectives of this study are: 1. To determine characters contributing to an understanding and interpretation of the nominal families and genera in the Order. 2. To determine the diagnostic characters in the analysis of the living and fossil species. 3. To determine the extent of differentiation of the various oceanic populations. 4. To study the hosts and the degree of specificity and association of the sharksuckers with other marine animals. 5. To correlate morphology with behavioral evolution among the species.

SUPPORTED BY Smithsonian Institution

5.0251, PARASITES OF PHILIPPINE FISHES

C.C. VELASQUEZ, Smithsonian Institution, *Washington, District of Columbia* 20560

(1) Preparation of manuscript of completed studies on trematodes and nematodes of freshwater and marine fishes. (2) Collection of more specimens for intraspecific variation. (3) Life cycle studies will be done when materials are available. (4) Studies on distribution, ecology and host-parasite relationships will be done when feasible.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5. LIVING SYSTEMS (NON-HUMAN)

5.0252, STOCK IDENTIFICATION OF ATLANTIC TUNAS

J.P. WISE, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab. , *Miami, Florida*

An investigation of tuna population genetics by biochemical or serological means is being undertaken in the Atlantic. This study is an investigation of the genetic composition of tuna populations in the Caribbean and the tropical Atlantic by means of electrophoretic analysis of selected enzymes in tuna tissues.

Lactic dehydrogenase, malic dehydrogenase, and esterases are being studied because of their universal distribution in fish tissues, their multi-gene control, and the allelic forms of the genes, which may render these enzymes excellent tools for studies of tuna population genetics.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0253, BEHAVIOR AND SENSORY PHYSIOLOGY OF SHARKS

A. MYRBERG, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124 (NONR)

Objective: Sharks pose a physical, as well as psychological, hazard to personnel in the sea for operational or recreational purposes. They may also cause the loss of moored and floating equipment since they are capable of biting through thick armored cable and of puncturing flotation gear. In order to develop effective shark repellents and survival techniques, it is necessary to determine the factors in the environment which the shark can perceive and which it may use in locating and identifying sources of food.

Approach: The investigator is studying and measuring the sensitivity and range of vision and audition of a variety of shark species. He utilizes behavioral, as well as physiological responses obtained by electrocardiogram, respiration rate measurements as indicators of stimulus reception. Additional mechanisms are being used to detect responses, especially to sound and light which may be more accurate and quantitative than gross behavior patterns. The Acoustic-Video Array is being used to conduct sound playback experiments with free-swimming sharks.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0254, RENEWAL RESEARCH PROPOSAL FOR HEARING AND ALLIED SENSES IN FISHES

A.A. MYRBERG, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

This work will be a continuation of research begun under grant GB-8 on hearing and allied senses in fishes. The principal and immediate objective of the proposed investigation is to obtain basic information about the quantitative aspects of hearing in fishes and on the physiological mechanisms of their hearing. Such information, when accompanied by appropriate behavioral studies, should be helpful in understanding how these animals utilize acoustic energy for the detection and location of moving objects and for orientation and communications. It is expected that major exphasis will be placed on measuring the acuity and sensitivity of these senses in the initial phases of the investigation and that later phases will deal with the significance of various sounds of animal origin to fishes as well as their ability to orient to sounds of underwater origin.

SUPPORTED BY U.S. National Science Foundation

5.0255, IMMUNE MECHANISMS AND RESISTANCE FACTORS IN MARINE FISHES

M.M. SIGEL, Univ. of Miami, School of Medicine, *Miami - Coral Gables, Florida* 33124

Immunological and immunochemical studies are being conducted in fishes at several phylogenetic levels. All of these animals are capable of responding to primary stimulation with a variety of antigens. They differ, however, in immunologic memory. So far, all antibodies, regardless of the duration of immunization, have been predominantly or exclusively associated with IgM, but a search for IgG in certain species is continuing. In some of these fishes, but not in all, antibody activity is associated with a 7S moiety of IgM which is believed to be the monomer of the 19S pentamer. Although these fishes lack certain of the components of the immune mechanism of higher vertebrates their immune mechanism is not readily depressed by factors and conditions known to suppress immunity in higher animals. Suppression of the primary, but not secondary, response has been obtained with 6-MP. The thymus and pronephros of two marine teleosts are directly involved in antibody synthesis. Studies on antigen metabolism and clearance are in progress.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0256, ARTIFICIAL SELECTION - FISH

D.L. COPPAGE, U.S. Dept. of Interior, Biological Laboratory, *Sabine Island - Gulf Breeze, Florida*

The objectives of this project are: (1) to determine if fish that survive lethal concentrations of pesticides possess some genetic factor that can be intensified in succeeding generations, and (2) to determine whether immature but rapidly developing ova concentrate proportionately more pesticide than mature ova, and to what extent pesticides affect embryonic development and hatching, or growth and vigor of the fry.

Fish surviving pesticide tests will be selectively bred to drastically alter the gene pool in favor of these individuals. We will continue this selection for as many generations as are necessary to achieve our objectives. We will also expose mature fish to radioactively-labeled pesticides to trace transport of these chemicals to specific tissues, especially reproductive. Fertilized eggs of several species of estuarine fishes will be exposed to various pesticides at different stages in embryonic development, and the responses of different age fish to toxicants will be studied.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0257, LIFE HISTORY STUDY OF THE MOI, POLYDACTYLUS SEXFILIS

R.K. KANAYAMA, State Dept. of Land. Nat. Res. , *Honolulu, Hawaii* 96813

Objectives: To study various aspects of the ecology and life history of the moi, Polydactylus sexfilis, with the ultimate objective of obtaining sufficient scientific information necessary for the proper management of this highly important salt water game species.

Procedure: 1. Assistance from selected sport fishermen and fishing clubs will be enlisted for the gathering of moi gonad samples and length -weight data. 2. A short manuscript on the hermaphroditic condition of the moi gonad will be prepared. Completion of the study on most aspects of the reproductive habits of this species is anticipated. 3. To obtain information on growth and migration, an intensive tagging program will be undertaken which will entail the capturing of moilii, tagging with an internal anchor tag, and the immediate release of the tagged fish. (Previously moilii were captured and reared for several months before being tagged and released). 4. Supplemental growth data will be acquired by releasing tagged moilii in several commercial fish ponds.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Hawaii State Government

5.0258, PROVIDE FOR ACTIVITIES OF TUNA BLOOD GROUP CENTER

K. FUJINO, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Honolulu, Hawaii* 96812

Since tunas are distributed in wide geographic areas, cooperation between national and international institutions and agencies is essential to accomplish population studies by immunological techniques. The Tuna Blood Group Center established at the Bureau of Commercial Fisheries Biological Laboratory, Honolulu, will serve as a focal point to foster this cooperative study. The Center will serve as a medium to standardize blood typing reagents and techniques thus making comparison of results produced by different institutions possible.

Recent exchange of serum specimens of skipjack and yellowfin tunas, already typed, between Tuna Blood Group Center and the Inter- American Tropical Tuna Commission, has made the identification of a genetic system in the serum transferrin component possible.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0259, INVESTIGATE PHYSIOLOGY OF TUNAS

E.L. NAKAMURA, U.S. Dept. of Interior, Behavior & Physiol. Prog., *Honolulu, Hawaii* 96812

The physiology of tunas is poorly understood. Knowledge of the functions of body processes of these fishes is essential to understand better the relationship of the distribution of tunas to environmental factors, their responses to variations in these factors, and the sensory mechanisms involved in these responses. Studies on the inorganic constituents of muscles and blood, on the role of red and white muscles, and on oxygen consumption by red and white muscles have been made. Some work has also been done on olfaction and on schooling behavior. Other physiological studies such as those on digestion rates, visual acuity, and auditory acuity have been made under other project titles. These studies have been made by university personnel under contract with the laboratory, by visiting investigators who were provided space and materials, and by laboratory personnel. Physiological studies in the immediate future will be made on oxygen consumption and body temperatures of tuna.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0260, STUDY OF THIAMINASE IN HAWAII FISH

D.M. HILKER, Univ. of Hawaii, Agricultural Experiment Sta., *Honolulu, Hawaii* 96822

1. To test for thiaminase activity in various species of fish found in Hawaiian waters. 2. To study physical properties such as pH and temperature optima, enzyma inhibitors, and separability into apo and coenzymes. 3. To carry out biological studies of thiaminase activity in fish using rats and human subjects.

This study involves the determination of thiaminase activity in fish caught in Hawaiian waters and the physiological significance of the ingestion of fish containing this enzyme by rats and human subjects.

SUPPORTED BY Hawaii State Government

5.0261, ISOLATION OF ANTI-THIAMINE FACTORS IN HAWAII FISH

D.M. HILKER, Univ. of Hawaii, School of Agriculture, *Honolulu, Hawaii* 96822

The principal objectives of this project include: 1. The isolation and identification of anti-thiamine factors in the muscle and viscera of Hawaii fish. 2. The study of the stability of anti-thiamine preparations to various treatments including ionizing radiation. 3. The study of the mechanism by which anti-thiamine agents inactivate thiamine.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0262, FACTORS AFFECTING THE BEHAVIOR OF SHARKS

A.L. TESTER, Univ. of Hawaii, Graduate School, *Honolulu, Hawaii* 96822

The proposed research will include continued studies on the identification, distribution, morphology, histology, innervation, and function of superficial neuromasts and lateralis, system of sharks. As more knowledge is gained with regard to innervation and function of the sensory organs, selected stimuli will be employed in order to conduct comparisons of resting potentials as opposed to action potentials resulting from the applied stimuli.

As a personnel menace, sharks constitute a severe moral problem. By studying the fundamental factors that effect and/or govern the behavior of sharks and other animals one can gain knowledge that can be used to develop more effective techniques and concepts of personnel protection.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0263, RATE OF ABSORPTION OF ENDRIN BY BLUEGILL SUNFISH

H.J. BENNETT, Louisiana State University, Graduate School, *Baton Rouge, Louisiana* 70803

The purpose of this research is to determine the effects of sublethal and lethal concentrations of endrin on bluegill sunfish, Lepomis macrochirus, and to study the rate of absorption by the entire fish and by selected organs.

The rates of absorption will be determined by exposing bluegills for varying time intervals in a constant flow system. This system has been used in our laboratory for several years and has given more valid results than a static system. Bioassay studies have been conducted by this laboratory since 1948 with the support of the Louisiana Wild Life and Fisheries Commission and the Louisiana Petroleum Refiners Waste Control Council. Until approximately five years ago all research was conducted with a static system. Holden (1962) stated that brown trout absorbed in less than 24 hours 90% or more of the 14C-labeled DDT to which they were exposed in a static system. Mount and Putnicki (1966) have also questioned the validity of the TLm values determined for insecticides in a static system. Hebert, Dowden and Bennett (in press) have shown that there is a significant difference between TLm values obtained in a static system and those obtained in a constant flow system.

In this study the fish will be exposed to the 24 hour TLm concentration and to one-tenth of this concentration for known periods of time. The entire fish and/or selected organs will be analyzed by electron capture gas chromatography, and, if necessary, by thin-layer chromatography.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0264, COMPARATIVE BEHAVIOR OF HATCHERY-REARED AND WILD SALMONIDS

W.H. EVERHART, State Inland Fish & Game Dept., *Augusta, Maine* 04330

This grant is for the continuation of research initiated under GB-3859, dealing with the behavior of hatchery-reared and wild juvenile salmon (Salmo salar). The purpose of the study is to determine whether or not young salmon raised in an artificial environment have behavioral deficiencies which may affect their survival beyond that normally expected in a wild population. The hatchery fish used in the experiments are the progeny of wild parents, and any departure from the behavior of wild salmon is considered a result of behavior modifications imposed by the hatchery environment. Observations are made in a 50-foot artificial stream approximating the natural stream environment in which long-term observations could be made. Aquaria are used to supplement field observations when experimentally controlled conditions are necessary.

Under the new grant the investigators will complete several phases of the study of salmon. They also plan to initiate a comparative behavior study of hatchery and wild brook trout (Salvelinus fontinalis), an investigation of the behavior of salmon and trout in the hatchery environment, and an investigation of the physiological effects of stress on the endocrine system of salmon and trout reared under different environmental conditions.

SUPPORTED BY U.S. National Science Foundation

5.0265, RACIAL STUDIES OF HERRING

G.J. RIDGWAY, U.S. Dept. of Interior, Biological Laboratory, *Boothbay Harbor, Maine* 04538

The stocks of herring in the areas of coastal Gulf of Maine, Georges Bank, and Nova Scotia are being studied with a variety of serological and biochemical methods to find genetically variable characters that can be used to identify and discriminate between reproductively isolated populations. Proper management of these stocks requires that the reproductivity isolated segments be recognized, since they are being harvested by several domestic and foreign fisheries. The serological approaches to the problem include work on blood groups and serum differences. Biochemical methods include a variety of electrophoretic methods coupled with methods which stain specifically for various enzymes. The data are analyzed by population genetic methods.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0266, COMPARATIVE ETHOLOGY OF FISHES OF THE GENUS MACROPODUS

C.H. SOUTHWICK, Johns Hopkins University, School of Public Health, *Baltimore, Maryland* 21218

Brief Description of Research Project: The proposed research involves comparative ethological studies of wild-trapped strains of the anabentid fishes Macropodus opercularis, M. cupanus, M. chinensis, and M. davi. The locomotory, feeding, resting, sexual, agonistic, parental, and communicative behavior of these species will be analysed in detail.

The greatest emphasis will be placed on qualitative and quantitative analysis of aggressive behavior. This will include data on normal ontogeny, on releasing and causative mechanisms, and on the influences of social variables on aggressive behavior.

In conjunction with the study of social influences, experiments will be carried out to determine the relationships between sociality, water conditions, and survival of young fish.

SUPPORTED BY U.S. National Science Foundation

5.0267, RESPIRATORY EXCHANGE IN FISH GILLS

C.E. BROWN, Hydronautics Incorporated, *Laurel, Maryland*

The purpose of this project is to provide a quantitative understanding of the mechanisms involved in the respiratory exchange of gases across fish gills. The study is designed to provide both detailed information on the counterflow system, and computer analyses of the exchange process. Attention will be given to the computation of gaseous losses in the lamellae, the ability of gill systems to recover oxygen and eliminate carbon dioxide with special consideration of the dissociation characteristics of these gases in respect to the sea water - Blood Media, and a complete analysis of the gill structure and pumping mechanism.

The increased incidence of Naval personnel in submerged oceanic situations, for example, free diving operations, excursions from underwater habitats, and other facilities, and the increasing utilization of submersibles of all types, emphasizes the need for detailed understanding of systems for gas exchange already successfully employed in the oceanic environment.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0268, PHYLOGENETIC SIGNIFICANCE OF SOUND-PRODUCING MECHANISMS OF OPHIDIOID AND RELATED FISHES

W.R. COURTENAY, Boston University, Graduate School, *Boston, Massachusetts* 02215

This project is concerned with the phylogenetic significance of sound-producing mechanisms in ophidioid and related fishes. The work is anatomical, investigating the structure of the sonic mechanisms is these fishes. It seems, provisionally at this time, that the morphology of these structures can be grouped into two basic patterns; if these are indications of relationships, some of the fishes in three formerly distinct families of fishes cross over presently-established phyletic lines. The significances of these indications are being studied.

SUPPORTED BY U.S. National Science Foundation

5.0269, REGULATION OF AMMONIA EXCRETION IN FISH AND AQUATIC AMPHIBIA

L. GOLDSTEIN, Harvard University, School of Medicine, *Boston, Massachusetts*

Investigations will be conducted on the regulation of ammonia production and excretion in fish and aquatic amphibia. Pathways of ammonia synthesis will be examined in teleosts and other fishes. Activities of amino acid deaminating enzymes will be assayed in tissue homogenates and optimal assay conditions will be defined. Substrate, cofactor and product levels will be measured in frozen sections of fish tissues and these values will be used to assess the rate of amino acid deamination in vivo. The adaptation of nitrogen metabolism (ammonotelism to ureotelism) that occurs in the lungfish (Protopterus dolloi) during estivation will be investigated. Levels of amino acid deaminating enzymes, substrates, cofactors and products and the activity of the ornithine cycle will be determined in estivating and nonestivating fish.

The adaptation of nitrogen metabolism (ammonotelism to ureotelism) that occurs in Xenopus laevis during water deprivation will be studied. The mode of ammonia excretion will be examined in artificially perfused kidneys. Changes in renal function during water deprivation will be assessed. The levels of amino acid deaminating enzymes, substrates, cofactors and products will be determined in both kidneys and livers from normal and dehydrated animals. The acitivty of the ornithine cycle will be measured in liver slices from both groups of animals.

SUPPORTED BY U.S. National Science Foundation

5.0270, BEHAVIOR IN EMBRYOS AS IT RELATES TO ENCEPHALIZATION

P.B. ARMSTRONG, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

This investigation will be concerned with the correlation of neuroanatomical mechanisms responsible for the negative phototaxis in developing Ictalurus nebulosis. Negative phototaxis appears when the rods and cones first show a development of the receptor elements. Throughout the major part of embryonic development this reaction persists. However, toward the end of embryonic development the photomechanical mechanisms characteristic of the adult eye appear and the embryos are able to adapt to light and darkness. The projection of the optic nerves to the lateral geniculates and the optic lobes is currently under investigation and the behavioral responses are being followed with partial and complete ablation of the optic lobes by electrocautery. Further extension of this work involves a study of the lateral line system and the Mauthner cells in the mechanism.

A subsidiary problem concerns the comparative physiology of the intriridial muscles involving these in the eel, goosefish and toad which show direct contractility to light.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0271, FURTHER STUDIES ON A FLUORESCENT COMPOUND IN THE DOGFISH LENS

J. TUTTLE, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY National Council to Combat Blindness Inc.

5.0272, THE PHYSIOLOGY OF TUNA AND OTHER PELAGIC FISH

F.G. CAREY, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

The main objective of this work will be the further study of the heat conservation mechanisms used by certain sharks and tuna to maintain body temperatures above their environment. We hope to get quantitative data to demonstrate how effectively the heat exchange mechanisms in these animals function and information on how they regulate their temperatures and make use of their ability to stay warm. When opportunity permits we will also carry out experiments with blood physiology and other aspects of the physiology of these fish.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0273, ENERGY REQUIREMENTS OF MARINE ORGANISMS

J.M. TEAL, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

Part of the work was devoted to studying the body temperature of warm bodied fishes, tunas, and Lamnid sharks, all of which possess countercurrent heat exchangers in the blood supply to their body muscles. We measured the distribution of internal temperatures in fish caught in fish traps, on long lines, and by sports fishermen. Body temperatures indicated that at least Blue Fin Tuna and Mako Shark have some mechanism for control of their body temperature and tend to remain at about 30 degrees and 28 degrees respectively. We also found high body temperatures associated with a poorly developed heat exchanger in Big-eyed Thresher Sharks. Maintenance of high temperature required high metabolism. Further work is being directed toward measurement of metabolic rates in some of these species.

SUPPORTED BY U.S. National Science Foundation

5.0274, DEVELOPMENTAL MORPHOLOGY OF COREGONIDS

L.E. CABLE, U.S. Dept. of Interior, Biological Laboratory, *Ann Arbor, Michigan*

Study of the morphology of young coregonids of the Great Lakes was begun to determine what differences exist between the several indigenous species. To date, seven species, one hybrid, and one Prosopium have been reared from the egg to adulthood in the laboratory. Some specimens of each species were preserved at intervals as development progressed. This phase of the work is completed.

Since completion of the first phase, from 20 to 60 morphometric characters have been measured or counted on many of the specimens at 10 mm. intervals of total length in search of one or more characters that can be used in the field to distinguish the young of one species from those of the other species. This morphometric data is being transferred to punch cards and programs written for electronic data processing to determine the potent independent variables and their reliability in multiple regression and/or discriminant analyses.

A paper in preparation will describe laboratory methods, food, growth, diseases, survival, and reproduction in the laboratory, also the morphometry of the first and second generation whitefish reared in captivity. The morphometry of the other species being analyzed along with that of the whitefish will be reported in separate papers.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0275, SIMULATED WEIGHTLESSNESS IN FISH

R. VONBAUMGARTEN, Univ. of Michigan, School of Medicine, *Ann Arbor, Michigan* (NGR)

Objective: a. Problem: To surgically produce a condition simulating weightlessness in fish. b. Applications: Elucidate the function of gravity receptors using the fish as an experimental organism. c. To collect information about aspects of weightlessness in an organism which permits elimination of the effects of gravity force on the cardiovascular system, and proprioceptive antigravity reflexes.

Approach: Iron particles will be implanted into the utricular statoliths, bilaterally. Strong magnetic fields will be applied at different directions, thus altering orientation, and behavioral observations made. Additional studies will be made using microelectrode recordings in marine organisms.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

5.0276, FISH HOLDING AND LIFE STAGE SENSITIVITY STUDIES

C.M. TARZWELL, U.S. Dept. of Interior, Natl. Water Quality Lab., *Duluth, Minnesota*

All fish of importance in the upper Great Lakes area will be collected and bought into the laboratory for sensitivity studies. As the work progresses, feeding and other procedures will be developed so that selected species can be kept through the winter for sensitivity studies. Species which comprise a significant portion of the total fish population will be used in the sensitivity studies to determine those species which are most sensitive to a particular material or waste. Not only will the adult, but the fingerlings and fry will be studied, as well as the eggs and sperm to determine the most sensitive development stage of these fishes. As with the other projects, the most sensitive form will be used in the Toxicological Unit for the determination of safe levels of a particular toxicant under conditions of long-term exposure.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0277, PESTICIDE RESISTANT FISH IN NATURAL ECOSYSTEMS

D.E. FERGUSON, Mississippi St. University, Graduate School, *State College, Mississippi* 39762

The applicant and his students first reported pesticide resistance in natural populations of fish in 1963. Since that time, our studies have concerned the extent and nature of resistance in vertebrates, and little effort has been directed to an assessment of the significance and potential of resistance to natural ecosystems. Recent findings indicate that the ecological impact of resistant populations of fish may be so great and macabre as to stagger the imagination. For example, large numbers of highly resistant mosquitofish are able to survive as 10-day exposure to 2000 ppb endrin. If a medium-sized predaceous fish eats just one of these survivors, death ensues in about 6 hours. We suspect that the same would be true of an egret, snake, turtle or any other predator. What about man?

In a paper now in press, we show that a single resistant fish exposed to 1000 ppb endrin will release sufficient toxicant into 10 liters of tapwater to kill 5 susceptible fish in 38.5 hours.

How much pesticide are resistant fish able to tolerate? How much do they actually contain in heavily contaminated areas? What predators eat them? What is the consequence? Are humans eating them? These are some questions we hope to answer, and it is a matter of urgency that they be answered quickly! Our objectives are to attempt to assess the actual and potential significance of the presence of resistant fishes in natural ecosystems.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0278, TOXICANT TOLERANCE STUDIES-SCREENING OF PESTICIDES AND FISH AT TIBURON

T. LANE, U.S. Dept. of Interior, Fish Pesticide Res. Lab., *Columbia, Missouri* 65201

The objective is to obtain acute toxicity information on marine and estuarine fishes with insecticides, herbicides, and other pesticides at Tiburon, California. Fish and toxicants will be tested in continuous-flow systems in the laboratory, according to a standard method, and the later will be treated by probit analysis to obtain LC50 values under various time schedules.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0279, MECHANISMS OF HOMING AND ORIENTATION OF SALMO CLARKI IN YELLOWSTONE LAKE AND ITS TRIBUTARIES

C.J. BROWN, Montana State University, Graduate School, *Bozeman, Montana* 59715

Since 1964 the principal investigators have been studying the movement behavior of mature, migrating cutthroat trout displaced from their homestreams to the open water of Yellowstone Lake, Yellowstone National Park, Wyoming. Evidence of within-season homing has been presented as a result of tagging experiments. It has also been demonstrated by float and ultrasonic tracking that cutthroat trout have oriented movement patterns, probably responsive to visual cues. Under the present grant the investigators will continue their research to determine: (1) some of the sensory mechanisms (particularly visual) of homing and orientation in open water particularly by the use of ultrasonic tracking; and (2) the extent, specificity, and sensory mechanisms of homing within a tributary system primarily by mark-and recapture methods.

SUPPORTED BY U.S. National Science Foundation

5.0280, OSMOREGULATION

T.B. THORSON, Univ. of Nebraska, Graduate School, *Lincoln, Nebraska* 68508

Marine fish and fresh-water fish are usually able to cope with only one external medium, but certain species are able to make the change successfully from one medium to the other. These euryhaline fish are especially appropriate subjects for osmoregulatory studies. Such species are the bull shark, Carcharhinus leucas, and the sawfish, Pristis perotteti, both of which occur in substantial numbers in the Lake Nicaragua-Rio San Juan System of Nicaragua and Costa Rica. I am studying the chemical anatomy of the serum, cranial fluid, perivisceral fluid, pericardial fluid, urine and rectal gland secretion of these elasmobranchs (1) taken from salt water, (2) taken from fresh water, (3) following transfer from fresh water to salt water and vice versa. These species appear to be marine animals that make their way into fresh water, but there are other elasmobranchs that are permanent residents of fresh water rivers and probably have been for thousands of generations. These are the river rays of the family Potamotrygonidae found in rivers of South America and Africa. The chemical anatomy of their body fluids will also be analyzed to determine whether they have retained the urea-retaining habitus of the marine elasmobranchs.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0281, MORPHOGENETIC MOVEMENTS IN FISH EMBRYOS

W.W. BALLARD, Dartmouth College, School of Medicine, *Hanover, New Hampshire* 03755

BRIEF DESCRIPTION OF RESEARCH PROJECT: Analysis of development must be based upon precise and full descriptions of the events and processes to be analyzed. The publication of 'fate maps' and charts of the patterns of movement of cells in gastrulation and early differentiation is a necessary prerequisite for the planning of further experiments. Although much work has been done on amphibian and chick embryos, very little attention has been focused on fish embryos. There are questions on interpretation of the function of the edge of the teleost blastodisc and evidence is available to show that the structures through which gastrulation is accomplished in fish are completely different from those in the amphibian and the chick.

The movements of the inner cells of the blastodisc of representative taxa of fishes are being explored and reliable 'fate maps' of the late pregastrula stage will be completed. Other questions to be answered are the source and method of gathering of the notochord and endoderm, the role of the embryonic shield as a growth center, the segregation of the germ layers out of the massive shield, the origin and fate of Kupffer's vesicle and the source and organization of the trunk-tail bud.

SUPPORTED BY U.S. National Science Foundation

5.0282, RETINAL RHYTHMS UNDER CONTROLLED LIGHT

B.L. OLLA, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

To determine whether photomechanical changes occur in the retinas of young bluefish and to measure the extent to which they are affected by internal controls. A group of bluefish will be kept under constant light and dark for three days. Fish will periodically be enucleated, and the eyes sectioned and stained. Measurements of the pigment and sensory layers will reveal the degree of internal control.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0283, LIGHT AND DARK ADAPTION IN THE RETINAE OF YOUNG BLUEFISH

B.L. OLLA, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

To determine the degree of photomechanical response in the retinae of young bluefish. Bluefish will be subjected to varying periods of light and darkness and their retinas will be removed, sectioned and stained. Measurements of the pigment and sensory cell layers will be taken to establish the degree of response and length of time required for complete light-and dark-adaptation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0284, RELATION OF TEMPERATURE TO RHYTHMIC BEHAVIOR

B.L. OLLA, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

To observe the effect of low water temperature on adult bluefish. Gradually lower the water temperature in a large sea tank while measuring swimming speeds. Determine the level which disrupts normal behavior.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0285, RHYTHMIC ACTIVITY OF BLUEFISH IN RELATION TO NORMAL LIGHT REGIME

B.L. OLLA, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

To determine whether a rhythmic pattern of activity is present in a group of bluefish residing in a tank under a 24 hour artificial day-night cycle: (1) measure average speed of swimming each hour of day and night as an index of activity; (2) tabulate, analyze, and plot resulting data to bring out statistically significant tendencies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0286, RHYTHMIC ACTIVITY OF BLUEFISH UNDER EXPERIMENTALLY VARIED LIGHT REGIMES

B.L. OLLA, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

To test whether the rhythmic activity of bluefish held in an experimental tank: (a) persists under low constant illumination, and (b) adapts to a change of phase in the day-night cycle: Measure activity of the fish under (a) constant illumination over varying lengths of time, and (b) an artificial day-night cycle which is seven hours out of phase with the original cycle. Analyze and compare the data with measurements collected under a normal light regime.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0287, AGE AND GROWTH OF BLUEFISH

L.A. WALFORD, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

To measure growth rates and determine age composition of bluefish populations occurring from Cape Cod to Southern Florida. Sample, measure and take scales from bluefish caught by commercial and sport fishermen and by research biologists, to represent full range of size along entire Atlantic coast. Study lengths and scales, and interpret their significance using standard techniques.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0288, ENDOCRINE REGULATED PROCESSES IN TELEOST FISHES

M.P. SCHREIBMAN, City University of New York, Graduate School, *Brooklyn - Brooklyn College, New York* 11210

Diverse mechanisms for osmoregulation are operative in fishes. How these mechanisms are interrelated is not well understood - undoubtedly their relative importance varies in the major groups of fishes. Some species must be maintained in dilute sea water following hypophysectomy. They will die if placed into fresh water, even though this may be their natural environment, unless injected with mammalian prolactin. In other species freshwater survival is independent of hypophysial control. The distribution of these two mechanisms may have considerable evolutionary significance. The aim of the proposed research is to determine the distribution of the two mechanisms along phylogenetic lines and to study the nature of the control.

To clarify the taxonomic picture, eight to ten species, belonging to several families and orders, will be hypophysectomized each year and tested for freshwater survival. The mechanisms involved will be investigated by the use of hypophysectomized fish, hormone replacement, and transplantation of endocrine organs. All organs that may be concerned with osmoregulation will be examined histologically for sites of hormone action. Cytological studies of pituitary glands, including cytochemical, autoradiographic, and ultrastructural methods, will be employed to ascertain the site of production of the hormone(s) involved with freshwater tolerance.

SUPPORTED BY U.S. National Science Foundation

5.0289, ACOUSTICO-LATERALS FUNCTION IN FISH ORIENTATION AND COMMUNICATION

P.H. CAHN, Long Island University, Graduate School, *Brookville, New York*

The research constitutes a many-pronged attack on the problem of the fishes' perception of his environment. The overall aim of the proposed study is to assess the relative importance of hydrodynamic and acoustic stimuli in fish orientation. Data is obtained by the following principal approaches: a. The behavioral analysis of pressure signal detection (auditory thresholds) and velocity/displacement signal detection (lateral-line thresholds) is being continued with concentration on the lower frequencies, between 10-100 Hz., in an effort to understand the way in which the two related detection systems are coupled. b. Neurophysiological, behavioral and histological analysis of the effects of environmental pollutants on the function of the car and lateral-line sensory systems will be undertaken. c. Three-dimensional analysis of the hydrodynamic structure of a fish school is being tried, and the importance of fish generated vortices for fish-to-fish orientation during schooling examined.

SUPPORTED BY U.S. National Science Foundation

5.0290, VISUAL CAPACITIES IN TELEOST FISHES

W.N. TAVOLGA, Amer. Museum of Nat. History, *New York, New York*

The investigator proposes to extend his research, now in progress under GB-4364, to study the visual capacities of teleost fishes. Avoidance conditioning techniques will be used to determine physicophysical thresholds for those aspects of the visual process clearly important in the behavior of fish. Among these, the perception of brightness, color, distance, movement and form should be included. In the first stage of this program of investigation measurements will be made on a number of species for each of these visual dimensions. The species chosen will differ morphologically and ecologically so that differences in behavior can be correlated with differences in structure.

SUPPORTED BY U.S. National Science Foundation

5.0291, AUDITORY CAPACITIES OF TELEOST FISHES

W.N. TAVOLGA, Amer. Museum of Nat. History, *New York, New York*

Brief Description of Research Project: This is a continuation of work begun under grant GB-1574.

Previous studies have shown the feasibility of determining auditory thresholds in fishes by the use of the avoidance conditioning technique. This method will be applied to a broad investigation of auditory capacities in teleost fishes of various groups, including those that prossess specialized hearing mechanisms such as the Weberian apparatus. Thresholds for pure tones, complex sounds and masked sounds will be determined, as well as tests for frequency and intensity discrimination. Phyletic comparisons and anatomical differences in auditory receptors will be correlated with differences in auditory capacities. Operative and other procedures will be used to sparate lateral line, swin bladder and direct bone conduction as auditory channels. Positive reward and other instrumental conditioning techniques will be used to study the effects of different testing methods on response thresholds to auditory stimuli.

SUPPORTED BY U.S. National Science Foundation

5.0292, CYTOLOGY OF VIRAL NEOPLASMS OF FISH

R. WALKER, Rensselaer Polytechnic Inst. , Graduate School, *Troy, New York* 12181

This is a continuing study of virus-associated skin lesions in fish, including lymphocystis disease (virus-induced hypertrophy) and various epidermal or dermal neoplasms.

Lymphocystis disease is being studied for viral ultrastructure, and for growth, chromosomal ploidy, and ultrastructure of the enlarging host fibro-blasts; and for structural, physiological, and immunological differences of virus or of the cytoplasmic DN-protein inclusions in different species. Studies are being initiated on the interaction of virus with gut cells, and phagocytes, with or without various adjuvants. Though arthropod vectors may not be necessary, they are being sought. With the help of Dr. Forney of Cornell we hope to get seasonal correlates of incidence and rate of growth in Stizostedion of L. Oneida.

Virus-like particles are consistently found associated with patches of hyperplastic epidermis in Stizostedion, but histologically similar lesions in Perca have shown no similar virus. Likewise no virus is seen by electron microscopy in a very different epidemic of epidermal hyperplasia ('fish-pox'?) of Lepomis, the bluegill.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0293, ACCUMULATION OF RADIONUCLIDES BY VERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)

J.P. BAPTIST, U.S. Dept. of Interior, Radiobiological Lab. , *Beaufort, North Carolina* 28516

Estuaries and brackish water areas provide a nursery ground and habitat for many commercially important fish. They also provide receiving waters for waste products, including radioactive effluents from power reactors, hospitals, and laboratories. Marine vertebrates can concentrate radioactive elements which could be harmful to them and render them useless as seafood for man. Since the marine environment is complex and each estuary is different, in some way, from all the others, various factors influencing accumulation must be studied under laboratory conditions.

The objectives of this project are to measure under controlled laboratory conditions, the accumulation and retention of radionuclides by marine fish; to study the importance of various factors which may affect accumulation; and to observe the feeding processes of commercially important fish through the use of radioactive tracer techniques.

Experiments are conducted with several marine fishes such as croakers, Micropogon undulatus; mummichog, Fundulus heteroclitus; pinfish, Lagodon rhomboides; bluefish, Pomatomus saltatrix; and flunder; Paralichthys sp. Accumulation of radionuclides both from sea water and from natural food containing radioactivity in known concentrations is determined.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0294, THE EFFECTS OF RADIATION ON THE PHYSIOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)

D.W. ENGEL, U.S. Dept. of Interior, Radiobiological Lab. , *Beaufort, North Carolina* 28516

Ionizing radiation has always been a part of the natural environment; however, the advent of the atomic age has increased the amount of radioactivity in the environment. The marine environment is subject to possible radioactive contamination from the growing numbers of reactors as well as from fallout and waste disposal. Though it is known that marine organisms tend to concentrate radionuclides, very little is known about the effects of ionizing radiations on these organisms. A more complete understanding is needed of species sensitivities to radiation and specific physiological effects of acute and chronic exposures. This information will aid in predicting effects from radioactivity in the environment and in applying controlled irradiation to eradicate undesirable species or to breed desirable species that are more resistant to environmental stresses. The purpose of this project is to describe the effects of acute and chronic doses of radiation from both internal and external sources on the physiology of marine organisms.

The effects of radiation may be death or alteration in some physiological or metabolic activity. In this investigation, LD-50's will be used to describe species sensitivity to radiation under varying conditions; while blood components, hematopoietic tissues, and respiration rates of whole organisms of tissues will be used as indices of radiation effects.

Sources of radiation will be by Cobalt-60 irradiators, an x-ray machine, labeled food, and administered radionuclides. Standard hematological and manometric techniques will be used to measure the various parameters. The marine teleost fishes used in this project will include Opsanus tau, Paralichthys sp., Pomatomus saltatrix, and Scomberomorus maculatus. The project will also encompass representatives of other groups of marine organisms.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0295, THE EFFECTS OF RADIATION ON THE MORPHOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)

J.C. WHITE, U.S. Dept. of Interior, Radiobiological Lab. , *Beaufort, North Carolina* 28516

5. LIVING SYSTEMS (NON-HUMAN)

Little is known about the effects of ionizing radiation on marine organisms. There is no information available on which to predict possible effects from accidental or purposeful irradiation. Due to the possibility of radiation being used as a tool in the management of the marine environment, it is essential that more knowledge of its effects be gathered. This project has been undertaken to help evaluate the effects of radiation on marine organisms by investigating comparative radiation sensitivities and morphological changes due to radiation.

Marine organisms may be exposed to radiation from both external and internal sources. Such irradiation may be chronic or acute and may cause either the death or an alteration in the morphology of the organism. Since the embryological and larval stages of marine organisms are more sensitive to radiation than mature forms, these stages, as well as mature organisms, will be exposed to various doses of radiation to determine LD-50's. Irradiated organisms will also be observed for any morphological changes that might develop as a result of acute or chronic doses.

Organisms will be irradiated by either Cobalt-60 sources, an x- ray machine, radioactive food and medium, or force fed radionuclides. The organisms being used presently are marine teleost fishes which include Fundulus heteroclitus, Paralichtys dentatus, P. albigutta, P. lethostigma, Menidia menidia, and Eucinostomus sp.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0296, STUDIES ON MOLTING, GROWTH, AND DEVELOPMENT IN ACORN BARNACLES AND LARVAL DECAPODS

J.D. COSTLOW, Duke University, Graduate School, *Durham, North Carolina* 27706 (NONR)

Objective: The problem of barnacle fouling on Naval vessels and underwater structures involves a complex sequence of endogenous biological activities which are largely endocrinological in nature. A clearer understanding of the endocrine mechanisms involved in the barnacle life cycle may facilitate prevention of their occurrence in the future.

Approach: The origins of endocrine systems are being investigated in the developmental stages of barnacle (larvae) in an attempt to localize the regions and time of appearance of areas of endocrine activity. Additionally, the functional period of these sites of endocrine activity is being studied and the effects of experimental extirpations, injection, and implantation documented. Due to the minute size of the sites of endocrine activity, micro-laser techniques will be used to selectively destroy endocrine sites.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0297, SUBCELLULAR REACTION TO INJURY IN THE KIDNEY

B.F. TRUMP, Duke University, School of Medicine, *Durham, North Carolina* 27706

The principal research objective is the delineation, at the subcellular, supramolecular, and molecular levels, of the response of kidney cells to lethal as well as sub-lethal injury. The principal emphasis is on the structural and functional modulation of cellular membranes as they relate to modification of energy transduction by these systems. Complementary objectives include an understanding of the ultrastructural characteristics of human renal disease, methods of ultrastructural and cytochemical analysis, and the ultrastructural basis of active transport. Particular attention has been given to the study of systems such as isolated, perfused flounder tubules and toad bladders in Ussing chambers, where correlations between alterations of structure and function can be made.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0298, THE INFLUENCE OF ENVIRONMENTAL FACTORS UPON DEVELOPING MERISTIC STRUCTURES IN THE MARINE FISH, FUNDULUS MAJALIS (WALBAUM)

W.E. FAHY, Univ. of North Carolina, Institute of Marine Science, *Morehead City, North Carolina* 28557

Physiologically ripe ova, developed naturally or induced by administration of chorionic gonadotropin hormone, are fertilized artificially with sperm from wild males in the laboratory at night using indirect fluorescent light. Embryos and larvae are reared in a unique salt-water circulating apparatus at recorded constant temperatures or alternating temperature regimes. Transfer of embryos and larvae from one temperature to another at different morphological stages are made to determine periods of response of the different structures (vertebrae, fin rays, basal support of fins, scales), those periods in development when response is greatest, and the extent and direction of responses. Fish are sacrificed at about 25 millimeters total length, fixed, cleared, stained in alizarinred and preserved in glycerine. Counts of different structures are made under a dissection microscope and these counts are subsequently treated with appropriate statistical procedures that permit identification of means drawn from heterogeneous statistical populations. These experiments, utilizing temperature at first, will be expanded to include salinity, light, and dissolved gases, to obtain a fuller knowledge of the mechanisms involved in raciation among fish species.

SUPPORTED BY University of North Carolina

5.0299, THE EFFECTS OF ENVIRONMENTAL CONDITIONS ON THE SPAWNING AND SURVIVAL OF FRY OF THE WALLEYE

V.C. APPLEGATE, U.S. Dept. of Interior, Biological Station, *Sandusky, Ohio*

The recent decline of walleye stocks in Lake Erie following a man induced acceleration of the eutrophic process in the lake demands investigation of the many environmental factors which might influence the survival of young walleyes. Temperature monitoring stations have been established on three known walleye spawning grounds (reefs) in the western basin with the object of determining the effect of temperature regimes during spawning and fry development in the success of walleye hatches. These records will also be used to determine the effects of temperature on the timing and abundance of food organisms that may be essential to the survival of walleye fry when they first begin feeding.

Walleye fry have proved elusive and difficult to capture during their first 6 weeks of life. Measurement and recording of the direction and velocity of water currents on these reefs during the walleye spawning season have been instituted with the objective of casting some light on the dispersal of the fry.

Subsequently, automatic devices for the regular and periodic sampling of plankton organisms on and near the reefs will be devised and incorporated into this experiment. Qualitative and quantitative examination of these samples will be compared with the planktonic diet of fry captured during their first weeks after hatching.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0300, THE EVOLUTION AND CAUSATION OF SOCIAL BEHAVIOR IN ANABANTOID FISHES

R.J. MILLER, Okla. St. Univ. of Agr. & Sci. , Graduate School, *Stillwater, Oklahoma* 74075

Brief Description of Research Project: This grant is for continuing and expanding studies on the social behavior of anabantoid fishes, currently being supported under GB-1989. Under the present grant, qualitative descriptions of the courtship and reproductive behaviors of Trichogaster trichopterus, T. leeri, Macropodus opercularis, and Betta splendens have been completed, and a comparative paper is being prepared for publication. A quantitative description and causal analysis of the reproductive behavior of T. leeri is in preparation, and data for similar analyses in the other species are still being collected. Long-term fluctuations in behaviors of several functional types are being compared in T. trichopterus and M. opercularis, and studies attempting to correlate such fluctuations with environmental cues are in progress.

Under the new grant several lines of work will be initiated as soon as possible. Descriptive and quantitative studies on several new species will be undertaken. Experimental work using models and test fish will be carried out to test hypotheses based on observational studies already completed. Mathematical indexes will be developed for comparing activity levels within and between species and individuals. These studies should provide objective data for evaluating the nature of evolutionary changes in behavior patterns in the group, and contribute to our knowledge of causation of aggression, reproductive actions, and parental behavior.

SUPPORTED BY U.S. National Science Foundation

5.0301, IONOCYTE FORMATION IN GILL EPITHELIUM OF FISHES

F.P. COTE, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

The proposed study is concerned with the developmental pattern of proteins and nucleic acids involved in the cellular differentiation of salt secreting cells in the gill epithelium of fishes. Kinetic studies by Conte and Lin (1967) have shown that increased salinities of the environment induces a rapid turnover of epithelial cells in gill tissue. Ultrastructural studies by electron microscopy (Newstead and Conte, 1967) support the hypothesis that the mitochondria-rich cells are the type of cells which are undergoing rapid synthesis and degeneration. Immunochemical study (Conte and Morita, 1967) of the gill filaments from saltwater and freshwater adapted fish have shown that levels of antigenic proteins are higher for the saltwater environment. Tripp, (1967) investigating the succinic acid dehydrogenase-cytochrome-C-reductase in gill tissue found no change in enzymatic activity between the two types of environments. Current experiments with labeled substrates are being performed in order to determine the casual relationships between protein and nucleic acid synthesis with salt secretion.

SUPPORTED BY U.S. Atomic Energy Commission

5.0302, INFECTIOUS DISEASES OF SALMONID FISHES

J.L. FRYER, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

Objective: (1) Study the epidemiology and transmission of infectious diseases in populations of fishes with emphasis on certain bacterial agents. (2) Investigate the use of immunological methods for both prevention and diagnosis of fish diseases. (3) Determine the source of infection, life history and means of tranmission of infectious protozoa.

Description of Work: This investigation is funded by the Fish Commission of Oregon and is designed to furnish information required for improved operation of their fish culture program. The objectives listed above cover the three key areas currently covered in the project and are believed to represent some of the most improtant disease problems related to fish hatcheries. The research will contain both basic and applied experimentation. The detection, prevention and control of fish diseases will be emphasized in all studies.

SUPPORTED BY Oregon State Government

5.0303, CRYOGENIC PRESERVATION OF VIABLE FISH SPERM

H.F. HORTON, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

The investigation has four objectives: 1) to develop a suitable diluent(s) and a life protector(s) for fish spermatozoa; 2) to perfect a freezing and thawing procedure for the live preservation of fish sperm at temperatures of liquid nitrogen; 3) to compare the reproductive capacity of sperm cells stored at cryogenic temperatures to that of fresh spermatozoa; 4) to compare the vitality of progeny produced from stored spermatozoa to that of progeny produced from fresh spermatozoa.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0304, NUTRITION OF SALMONID FISHES

D.K. LAW, Oregon State University, Agricultural Experiment Sta. , *Corvallis, Oregon* 97331

Objectives: (1) To investigate the fundamental nutrition of hatchery salmonids. (2) To further develop and improve, both nutritionally and economically, the Oregon Moist Pellet. (3) To develop a nutritionally adequate and physically available starter diet for young salmonids.

A completely purified diet for salmonid which will produce growth responses as good or better than the Oregon Moist Pellet (OMP) for investigation of the fundamental nutritional requirements of salmonids will be developed. Experiments will be conducted to expand the body of knowledge about the vitamin, mineral, amino acid, and fatty acid requirements of salmonids. The purified diet will be used to evaluate new, more nutritional and economical sources of protein for use in formulating the O.M.P. Modifications in the composition of the O.M.P. to enhance its manufacturing, feeding, and nutritional qualities will be investigated. Means of preserving the O.M.P. by methods other than freezing will be investigated. Basic methods of evaluating nutritive value and quality will be investigated to provide a more critical criteria for evaluating the qualtiy of the OMP. A nutritionally sound and physically available starter diet for juvenile salmonids will be developed.

SUPPORTED BY Oregon State Government

5.0305, BIOCHEMISTRY AND PHYSIOLOGICAL ECOLOGY OF POISONED FISH

S.D. LU, Oregon State University, Agricultural Experiment Sta. , *Corvallis, Oregon* 97331

Objectives: 1) The manner in which particular nerve enzymes are altered by selected toxic substances and how and to what extent this restricts the nervous performance of fish in terms of change resulting in patterns of social behavior will be determined. 2) The manner in which particular enzymes involved in muscular function are altered by selected toxic substances and how and to what extent this restricts the work performance of fish in terms of maximum short term swimming speed and length of time that this speed and also the maximum sustained swimming or 'cruising' speed can be maintained will be determined. 3) The manner in which particular digestive enzymes are altered by selected toxic substances and how and to what extent this restricts the utilization of food or energy resources in terms of growth and maintenance of fish will be determined. 4) The manner in which particular respiratory enzyme molecules are altered by selected toxic substances and how and to what extent this restricts the 'scope for activity' (experessed as the difference between standard and active metabolism) or capacity for nervous, work and growth performance of fish will be determined.

Description of Work: This investigation is concerned with the long term exposure of the organism to sub-lethal levels of toxicant. The nervous behavior and physiological function of the organism will be followed following exposure and the effect of the toxicant on specific enzymes assayed and related to the response. Studies on the long term effect of chemicals on the ecology of the fish will be evaluated. The mechanism of action of the poisons will be investigated.

SUPPORTED BY Oregon State Government

5.0306, EPIDEMIOLOGY OF SALMON POISONING DISEASE

R.E. MILLEMANN, Oregon State University, Agricultural Experiment Sta. , *Corvallis, Oregon* 97331

To determine the natural definitive host(s) for the fluke and rickettsiae; and to determine whether animals, other than canids, experimentally infected with the trematode also harbor the rickettsiae. By examination of wild animals trapped in the field; and by controlled infection experiments in the laboratory.

To determine if fluke eggs and miracidia carry the rickettsiae and are capable of transmitting the disease to susceptible dogs; and attempt to locate the rickettsiae in various fluke stages. By injection of various stages of the fluke parasite into susceptible dogs; and by use of the fluorescent antibody technique.

To study the relationship between the parasite and fish with emphasis on: a. the effect of changes in salinity on retention of the parasites and rickettsiae by anadromous salmonid fish; b. the susceptibility of non-salmonid fish to infection; and the comparative susceptibility of native and introduced species of salmonids; c. the effect of various levels of infection on the growth and swimming performance of salmonids under controlled conditions.

By examination of ocean-caught salmon and other fish; and by controlled infection experiments in the laboratory.

SUPPORTED BY Oregon State Government

5.0307, EPIDEMIOLOGY OF SALMON POISONING DISEASE

R.E. MILLEMANN, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

Studies on the effects of different infection levels with the 'salmon poisoning' trematode Nanophyetus salmincola on the growth and swimming performance of salmonid fishes under controlled conditions are being continued. The chemical and physical factors necessary for development and hatching of the trematode eggs will be determined. Studies on the mechanism of pathogenicity of the trematode for its fish host are being continued. Studies on the in vitro cultivation and characterization of the 'salmon poisoning' disease agent Neorickettsia helminthoeca are being continued.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0308, OCCURRENCE OF THE PROTOZOAN PARASITE CERATOMYXA IN ADULT PACIFIC SAIMON AND STEELHEAD TROUT

K.S. PILCHER, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

Objective: To determine the best technique for diagnosing this disease in salmonids. By means of a survey determine the species of fish involved at selected locations and obtain an estimate of the number of animals infected at each. Describe the pathology and causative agent.

Description of Work Proposed: Experimental procedures, sampling techniques and study areas will be determined in consultation with Drs. Fryer and Pilcher, Department of Microbiology, O. S. U., and the graduate student working on this project. This survey is to be conducted from a prearranged schedule which will indicate the species, location and sample size. Techniques for detection of this agent in fish tissue will also be examined. Tissue smears will be used initially until better methods are developed.

SUPPORTED BY Oregon State Government

5.0309, FISH GENETICS AND ECOLOGY

R.C. SIMON, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

To conduct original research in fish genetics and ecology. To apply findings of research toward clarification of existing problems of race identification, hatchery improvement, evolution of fishes, and study of estuarine ecology. To incorporate graduate instruction and research into each of the above objectives. Life history studies of marine and estuarine fishes. Population genetics. DNA homology studies. Cytogenetic and Mendelian genetic studies. Graduate level instruction in fish genetics.

SUPPORTED BY Oregon State Government

5.0310, CRYOGENIC PRESERVATION OF VIABLE FISH SPERM

UNKNOWN, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

Objectives: (1) To develop a suitable diluent(s) and a life protector(s) for fish spermatozoa. (2) To perfect a freezing and thawing procedure for the live preservation of fish sperm at temperatures of liquid nitrogen. (3) To compare the reproductive capacity of sperm cells stored at cryogenic temperatures to that of fresh spermatozoa. (4) To compare the vitality of progeny produced from stored spermatozoa to that of progeny produced from fresh spermatozoa. The long-term goal is to develop a method for the preservation of viable fish spermatozoa so that the costs of fish cultural operations can be reduced and research into fishery genetics and disease can be advanced.

Description of Work Proposed: The development of a suitable extender will require the empirical testing of a number of promising chemicals. Sperm cells will be collected in the field, placed on ice, and brought to the laboratory. 'Slow' to 'rapid' rates of freezing the spermatozoa samples will be tested to determine the best procedure. The ampules of frozen semen will be stored at minus 196 C in a liquid nitrogen refrigerator. When a procedure has been developed that will yield a satisfactory percentage of active spermatozoa, the refrigeration time will be extended to 7, 30, and 90 days. Sperm cells which have survived 2 or 7 days of freezing should endure indefinite cryogenic preservation. In the second general phase of the research, the reproductive capacity of sperm cells that have been frozen for 7 days at minus 196 C will be compared to that of fresh spermatozoa. Techniques of fertilization and comparative vitality of offspring will also be studied.

SUPPORTED BY Oregon State Government

5.0311, EFFECTS OF KRAFT PULP MILL EFFLUENTS ON THE GROWTH AND PRODUCTION OF FISH

C.E. WARREN, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

Objective: The general objective of this work is to determine how and to what extent concentrations of kraft pulp mill wastes that are neither acutely toxic nor severely oxygen depleting may influence the production of fish populations.

Description of Work: (1) Determine the influence of effluents from kraft pulp mills on the growth of juvenile salmonids in the laboratory when food consumption rates and metabolic requirements of the fish are similar to those of fish in nature. (2) Determine the influence of effluents from kraft pulp mills on the food consumption, growth, and production of salmonids and on the production of their food organisms in simplified biological communities in laboratory streams. (3) Determine the influence of kraft mill effluents on the food habits, food consumption, growth, and production of salmonids, and on the biological communities of controlled experimental streams in which the concentrations of these wastes are controlled at levels below those known to be toxic or seriously oxygen depleting. (4) Determine through sampling studies above and below the points of entry of kraft pulp mill effluents into rivers the food habits and growth rates of salmonids and other fish.

SUPPORTED BY Oregon State Government

5.0312, THERMALMETABOLIC RELATIONSHIPS OF STENOTHERMAL FISHES

R.W. MORRIS, Univ. of Oregon, Graduate School, *Eugene, Oregon* 97403

This renewal of GA-422 is for the purpose of investigating the otoliths of fishes to determine if otoliths function as pressure transducers. Preliminary anatomical studies of Antarctic fishes reveal that they lack a gas bladder or compressible vesicle that might serve as depth indicators. Observations of the effect of temperature and light gradients in depth stratification indicates that these are of minimal importance. X-ray diffraction of otolith structures prove that they are composed of aragonite, a centrosymmetric crystalline and nonpiezoelectric substance. The proposed extension will continue studies and experiments to develop surgical techniques for making experimental preparation of the labyrinth; development of means for stimulating and monitoring activity on the otoliths and eighth nerve; and develop pressure chambers and sound transducers essential for the experimental work.

SUPPORTED BY U.S. National Science Foundation

5.0313, PHOTOBIOLOGY OF MARINE ANIMALS

J.A. NICOL, Univ. of Oregon, Graduate School, *Eugene, Oregon* 97403

The tapeta lucida of fishes reflect light passing through the retina and are important in vision. Organization of the reflecting layers is being studied and fine structure of the reflecting cells is being revealed by light and electron microscopy. Reflectance is produced by constructure interference in stacks of guanine crystals; arrangement, spacing and thicknesses of the crystals are being determined. Values for reflectivity of the tapetum lucidum, spectrum reflectance curves, and transmission of the dioptric structures and of the retina are being sought to evaluate the complementary role of the tapetum lucidum in vision. Changes in all variable components during light and dark adaptation are being measured, using photo electric recording. The pigments - purines and others - in the tapetum lucidum are being extracted, isolated, identified and measured by mechanical, enzymatic, spectrophotometric and chromatographic methods now being explored and developed. The investigation embraces selachians, chimaerids, and sturgeons, whose tapeta lucida exhibit interesting divergences related to habits and habitats.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0314, EPIDERMAL PAPILLOMAS IN PLEURONECTID FISHES

S.R. WELLINGS, Univ. of Oregon, School of Medicine, *Portland, Oregon*

The general purposes of the project are: (1) determine the distribution of epidermal papillomas of pleuronectid fishes in Puget Sound, and relate this distribution to qualitative and quantitative features of the local ecology; and (2) establish in so far as possible the primary and secondary etiological factors involved, including a search for a possible viral agent.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0315, ANALYSIS OF SALMONID SCALES

A.L. OAKLEY, State Fish Commission, *Salem, Oregon*

Purpose: To determine age of salmon and steelhead by analysis of scale samples collected throughout the state. To identify different races of salmon and steelhead in the Columbia River.

Methods: To interpret the age, from scale samples, of important anadromous salmonid species, and determine if racial identification is possible by using scale characteristics.

Results: An individual has been hired and trained for this work and has remained with the project since its beginning. Enlarging equipment, utilizing a microprojector and viewing screen, was constructed. The ages of over 75,000 salmonids caught by commercial fishermen have been interpreted from scale impressions. A study to determine racial composition of spring-run chinook salmon is in progress. Growth characteristics during freshwater residence have also been used to determine hatchery or wild origin.

Reports: Annual Progress Reports.

SUPPORTED BY Oregon State Government

5.0316, DEVELOPMENTAL ANALYSIS OF FUNDULUS

J.M. OPPENHEIMER, Bryn Mawr College, Graduate School, *Bryn Mawr, Pennsylvania* 19010

Two projects will be undertaken: 1) transplantation of portions of the fish, fundulus, embryonic shield after dis-and reaggregation of their cells at gastrula states; and 2) characterization and localization of lipids and phospholipids in the developing central nervous system of Fundulus.

Thirds of the embryonic shield of Fundulus, obtained by dividing the shield along its anteroposterior axis, developed when grafted to extraembryonic membrane after being minced mechanically. The grafts resulted in the formation of surprisingly well-organized heads, trunks, or tails. It is proposed to extend these observations by grafting pellets of cells consisting of dis-and then reaggregated cells of portions of the embryonic shield. The portions of the shield to be tested will be 1) anterior, middle and posterior thirds of the shield, and 2) each germ-layer of the whole shield insofar as these have been separated at the stages at which the experiments are to be performed.

It is also proposed to study the lipid, especially the phospholipid, composition of the developing brain of Fundulus at specified stages.

Studies will be qualitative and quantitative, and will include attempts to localize particular components. The major source of nutrition for the embryo during the stages to be studied is the yolk; this too will be examined to determine changes in its lipid and phospholipid spectrum. If time permits isotopic studies will be made to elucidate the transport of inorganic and organic phosphate from yolk to embryo.

SUPPORTED BY U.S. National Science Foundation

5.0317, NUTRITION AND PHYSIOLOGY OF MARINE FISH IN CONTROLLED GNOTOBIOTIC ENVIRONMENTS

H.A. DYMSZA, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

Since natural ecosystems are extremely complex and not readily unraveled, the objective of the gnotobiotic approach of this project is to study the nutritional ecology of simple marine systems as integrated wholes. The advantages of gnotobiology are an ability to create ecosystems of known composition and the control of important variables. To this end, a modular 3-tank recirculating artificial sea water, germfree-gnotobiotic acquarium has been constructed. The system has provision for control of temperature, light, water circulation, water filtration, oxygenation and air filtration and flow. Parameters which can be measured include temperature, pH, oxygen, sodium, chloride and nitrate contents. Concurrently, while the gnotobiotic system was being built, Artemia salina was reared under various environmental and gnotobiotic conditions. In these studies, sterile natural diets were found to be superior to sterile semi-purified diets. Additional experiments were concerned with incubating and hatching 'clean' fish eggs. Procedures for egg decontamination and for sterility testing were also standardized.

SUPPORTED BY U.S. National Science Foundation

5.0318, ACOUSTICAL COMMUNICATION IN AQUATIC ORGANISMS

H.E. WINN, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

It is proposed that we concentrate on several problems that have been explored to date. One is the detailed functional properties of the calls of toadfish and squirrelfish. Playing back sounds organized in various ways will be emphasized. Hearing studies, both electrophysiological and behavioral, will be carried out. Through brain anatomical studies and brain stimulation, both fixed and under free conditions, certain of the areas that control sound production can be delineated. In this way sound communication in several species of fish can be better understood.

Also, in navigation the properties of the sun-compass will be studied and an attempt will be made to find the cues that allow eels to leave fresh water and locate the distant spawning grounds in the southern Atlantic.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0319, BLOOD TYPES AS INDICATORS OF BLUEFISH RACES

P.H. EDMUNDS, U.S. Dept. of Interior, Marine Game Fish Research Lab., *Narragansett, Rhode Island* 02882

Blood types in fishes, as in higher vertebrate classes, are hereditary traits and are not subject to environmental modification.

The work plan is to use normal or immune animal sera, saline extracts of selected leguminous plants, or combinations of the three to detect red blood cell antigenic difference (blood types) among individual bluefish; to characterize and statistically compare bluefish populations separated in space of time with respect to proportions of populations exhibiting specific types; to classify related types into blood group systems and attempt to deduce genetic basis for their control; to evaluate results in light of existing hypotheses about bluefish population structure, attempting to differentiate reproductively isolated groups.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0320, HEMOGLOBIN VARIATIONS AS INDICATORS OF BLUEFISH RACES

P.H. EDMUNDS, U.S. Dept. of Interior, Marine Game Fish Research Lab., *Narragansett, Rhode Island* 02882

Hemoglobin commonly occurs in multiple forms, each of which may have its own distinctive physical and chemical properties. In some species all individuals have the same forms, although modification of the series may occur during ontogenetic development. In other species certain individuals possess hemoglobin variants which other individuals lack. Since individual differences of this kind generally are genetically controlled, they may be useful in differentiating reproductively isolated subpopulations (races).

The work plan is to analyze bluefish hemoglobins with electrophoretic, chromatographic, spectroscopic, or immunochemical techniques; to detect differences in hemoglobin assemblages among individual bluefish and to deduce genetic basis for differences; to characterize and statistically compare bluefish populations separated in space or time with respect to proportions of populations exhibiting various hereditary forms; to evaluate results in light of existing hypotheses about bluefish population structure, attempting to differentiate reproductively isolated groups.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0321, BLOOD TYPES AS INDICATORS OF WHITE MARLIN RACES

P.H. EDMUNDS, U.S. Dept. of Interior, Marine Game Fish Research Lab., *Narragansett, Rhode Island* 02882

Blood types in fishes, as in higher vertebrate classes, are hereditary traits and are not subject to environmental modifications.

The work plan is: 1. To use normal or immune animal sera, saline extracts of selected leguminous plants, or combinations of the three to detect red blood cell antigenic differences (blood types) among individual white marlin (Tetrapterus albida); 2. To characterize and statistically compare marlin samples separated in space or time to determine the geographical distribution of blood types; 3. To evaluate, on the basis of these comparisons, existing hypotheses about white marlin population structure.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0322, HEMOGLOBIN VARIATIONS AS INDICATORS OF WHITE MARLIN RACES

P.H. EDMUNDS, U.S. Dept. of Interior, Marine Game Fish Research Lab., *Narragansett, Rhode Island* 02882

Hemoglobin commonly occurs in multiple forms, each of which may have its own distinctive physical and chemical properties. In some species all individuals have the same forms, although modification of the series may occur during ontogenetic development. In other species certain individuals possess hemoglobin variants which other individuals lack. Since individual differences of this kind generally are genetically controlled, they may be useful in differentiating reproductively isolated subpopulations (races).

The work plan is: 1. To analyze white marlin hemoglobins with electrophoretic techniques; 2. To detect any differences in hemoglobin assemblages among individual marlin and deduce the genetic basis for differences; 3. To characterize and statistically compare marlin samples separated in space or time with respect to proportions of populations exhibiting various hereditary forms, thus attempting to differentiate racial groups; 4. To evaluate, on the basis of these comparisons, existing hypotheses about white marlin population structure.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0323, HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE FISHES

P.P. YEVICH, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab., *Wakefield - Kingston, Rhode Island* 02881

Histopathologic studies will be conducted on various species of marine fishes after exposure to pollutants. Studies presently are being conducted on mummichogs being exposed to Cd and Pb.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0324, PHARMACOLOGY OF METAL POISONING IN ESTUARINE FISHES

R. EISLER, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab., *West Kingston, Rhode Island* 02892

Pilot bioassays were conducted under laboratory conditons with mummichogs, Fundulus heteroclitus, against various metals abundant in solid wastes dumped off shore. Analyses by atomic absorption, and other methods, of mummichogs that died during exposure to high concentrations demonstrate measurable changes in elementary chemical composition. Tissues from fishes surviving sublethal exposures were also significantly different from controls in levels of one or more of the 25 metals measured The significance of these changes in terms of enviormental stress and metabolic pathways is being studied.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0325, HEMATOLOGICAL CHANGES IN F. HETEROCLITUS UPON EXPOSURE TO TOXIC METALS

E. JACKIM, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab., *West Kingston, Rhode Island* 02892

Killifish are exposed to various toxic metals for 96-hr. and 30- days periods. The fish are killed and hematological tests conducted to observe and change in the differential blood count. Hematocrit and blood cell morphology are also compared to that of control fish. Normal seasonal, sex and size variations are also correlated to changes in the blood pricture. Cadmium and lead are now under investigation. Cadmium shows a marked eosionphilia while the effects of lead are more subtle. Cadium also appears to increase the hemoglobin and hematocrits in F. heteroclitus.

The blood morphology in other species of salt water fish is also being studied.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0326, COMPARATIVE BIOCHEMISTRY OF PROTEINS FROM GULF FISH

A.H. BARTEL, Univ. of Houston, Graduate School, *Houston, Texas* 77004

Hemoglobin and serum proteins of individual croaker (Micropogon undulatus) and spot (Leiostomus xanthurus) are being investigated to determine whether variations in properties can serve as biochemical markers of breeding populations. Electrophoretic patterns of the proteins from croaker differ significantly from those of spot, even though these two fish resemble one another morphologically and belong to the same family. Hemoglobin polymorphism occurs in these species. On the basis of different electrophoretic behavior of hemoglobin polymorphs, at least two, and possible three, populations of croaker occur in Galveston Bay. Present work is directed towards the isolation of these molecular forms of hemoglobin to determine the nature of the variations, and whether these variations reflect genetic variations. Croaker hemoglobin has a sedimentation coefficient of 4.4S and appears to be homogeneous in sedimentation behavior even though electrophoretic heterogeneity is observed. Observed decreases in sedimentation coefficient in 2M-NaCl suggests that fish hemoglobin dissociates in strong salt solutions.

A major problem facing the commercial fisheries is the identification of larval shrimp. Therefore, a comparison of proteins from various species of shrimp was initiated this summer to determine if biochemical taxonomy could be useful. The best extraction procedure found so far is to grind shrimp abdomens with alumina in 10% solution of NaCl. Analysis of extracts of shrimp by gel electrophoresis shows the presence of 15-20 components, but results are too preliminary to form any conclusions concerning the variation observed.

During the course of this research, staff members of The Bureau of Commercial Fisheries Biological Laboratory and the Texas Parks and Wildlife Department have greatly assisted us in collecting and identifying the fish and shrimp.

SUPPORTED BY Robert A. Welch Foundation

5.0327, PHOTOBIOLOGY OF MARINE ANIMALS

J.A. NICOL, Univ. of Texas, Graduate School, *Port Aransas, Texas* 78373

Introduction - Photobiological studies of marine animals now being activiely pursued deal with: (a) Photoreception: the structure and function of photoreceptors; light perception and vision (Crescitelli, 1958; Clarke & Denton, 1962; Nicol, 1963). (b) Bioluminescence: the structure and function of luminous tissures and organs (Harvey, 1952; Nicol, 1955a, 1960d, 1962a, b; Boden & Kampa, 1964; Johnson & Haneda, 1966). (c) Pigmentation and structural coloration: the means by which the tissures of animals affect incident light, by

The present proposal is for an investigation of the tapetum lucidum of fishes. The grosser aspects of the structure and the functioning of this structure have recently been examined by light microscopy and optical means. Further work is to discover the submicroscopic organization responsible for the reflecting, and its significance.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0328, ECOLOGICAL EFFECTS OF ENVIRONMENTAL & LOW LEVEL POLLUTION STRESSES ON METABOLIC REQUIREMENTS FOR GROWTH OF GULF COAST FISHES

D.E. WOHLSCHLAG, Univ. of Texas, Graduate School, *Port Aransas, Texas* 78373

The purpose of this portion of the continuing study is the evaluation of the effects of low-level, sublethal natural and man induced stresses on the metabolic and growth characteristics of Gulf Coast fishes. Von Bertalanffy and Ivlev-Winberg models relating metabolism, feeding and growth are used in conjunction with multiple regression experiments, which relate oxygen consumption rates (respiration) to body size, swimming activity, salinity, oxygen depletion (pollution), and temperature. Field experiments and growth data collection are underway for the striped mullet (Mugil cephalus), the pinfish (Lagodon rhomboides) and the spotted sea trout (Cynoscion nebulosus) over a wide natural range of salinities and over all seasons. The construction of models for quantitatively predicting sublethal, but deleterious, stress effects from thermal, salinity, oxygen depletion (pollution) or other aberrancies will be attempted.

SUPPORTED BY U.S. National Science Foundation

5.0329, PHYSIOLOGY AND ASSAY OF PROLACTIN IN FISH

J.N. BALL, Univ. of Sheffield, *Sheffield, United Kingdom*

Prolactin from teleostean pituitary glands appears to be involved in electrolyte regulation and possesses only minimal and atypical pigeon crop and mammotrophic activities, and so cannot be assayed by the usual pigeon crop technique. We are engaged in developing and applying a bioassay for fish prolactin based on the unique ability of ovine prolactin to maintain plasma sodium in the hypophysectomized teleost Poecilia latioinna in freshwater, having demonstrated a linear relationship between log dose of prolactin and plasma sodium levels, and having also established that teleost pituitary homogenates produce a similar and parallel response. We plan to use this assay to determine the prolactin content of Poecilia pituitary in seawater and freshwater fish, and in fish transferred between the two media, and we shall relate our findings to morphological changes in the pituitary cells that secrete fish prolactin. We shall also attempt to allocate this biological activity to electrophoretically separated fractions of teleost pituitaries, and to determine whether immunologically active putative fish prolactin preparations possess biological activity, an essential step in the eventual isolation of fish prolactin. We plan to determine whether the Poecilia sodium-maintaining activity of bovine prolactin and of fish prolactin is separable from immunological activity, a point of great importance for considerations of the evolution of the structure and functions of prolactin.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0330, COLLECTION OF MATERIALS AND DATA FOR AGE-GROWTH ANALYSIS

E.B. JOSEPH, Virginia Inst. of Marine Sci. , *Gloucester Point, Virginia* 23062

The objective is to obtain hard parts (scales, otoliths, etc.) from ground fish of potential industrial importance in the area between Cape May, N. J. and Cape Hatteras, N. C. The hard parts will be obtained from fish that are caught in other phases of the project. Attempts to determine age and rate of growth by counting annual rings and measuring increments will be begun immediately but the analysis will be incomplete at the end of the fiscal year. This phase will be continued in subsequent fiscal years.

Age-growth data will supplement information on seasonal distribution and abundance of fishes in assessing the feasibility of industrial utilization of the ground fishes of the Continental Shelf. These analyses must precede any attempt to derive mortality rates, which will be a subject of a later sub-project.

Part 6 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Virginia State Government

5.0331, FISH BEHAVIOR AND PHYSIOLOGY

A.B. GROVES, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

The essential purpose of this work is to acquire a knowledge of intrinsic physical and sensory abilities of fish which relate to specific environmental factors encountered in migration and fish passage situations: A broader purpose is to assess the adaptive ranges of these capacities in different migratory fish stocks. This information will be applied to help predict or anticipate the effects on migrant fish of various river and estuarine development programs which are creating numerous changes in the environments of native stocks of commercially valuable species.

Specifically the work is with salmonids and involves measurements of fish capacities against selected environmental variables. This includes measurements of swimming performance abilities of juvenile and adult fish and activity patterns and responses of salmonid species. Studies also are made of sensory responses which may relate to migration and homing behavior, of physical and hydraulic factors that can injure fish in power turbines, of responses that may aid in diverting fish away from dangerous areas in turbines, and of effects on migrants of thermal shock such as that encountered by passing through heated effluents from thermal power plants.

The work is now in the laboratory but is directed to the idea that the derived information can be applied directly to field problems.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0332, PACIFIC FISH PHYSIOLOGY AND BIOCHEMISTRY (SALMON IMMUNOCHEMISTRY)

H.O. HODGINS, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

Biochemical and immunochemical methods are being applied to identification of populations of Pacific salmon and other economically important Pacific fish species.

The process of maturation in Pacific salmon, particularly Oncorhynchus nerka, is under study, using specialized biochemical techniques to extract and purify hormones, certain immunochemical procedures to examine maturity-related antigens, and histochemistry and bioassays to correlate structure with function.

Limited studies on the physiology of stress in fish are also in progress. Particular emphasis will be on cause, effects, and signficance of certain enzyme and hormone levels.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0333, IDENTIFICATION OF SOCKEYE SALMON STOCKS BY BONE MINERALS

R.L. MAJOR, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

A major objective of the Bureau of Commercial Fisheries' Seattle Biological Laboratory is to develop a basic knowledge about Pacific Salmon (Oncorhynchus spp.). Because no two stocks of a particular species of salmon have identical life histories, it is important to first identify the various stocks and then to collect the biological data for each stock. The objectives of this project are (1) to identify the important stocks of sockeye salmon by the chemical composition of their bony structures and (2) to use the chemical characters alone or together with other characters to quantitatively divide catches containing mixed stocks into their component parts.

To date we have collected samples from inshore areas spanning the Pacific Coast of North America and explored various methods of sample preparation and analysis. X-ray diffraction analysis and emmission spectro-photometry appear to be promising methods of analysis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0334, GULF OF ALASKA SOCKEYE SALMON SCALES, PROTOCOL AREA SOCKEYE SALMON SCALES, AND GULF OF ALASKA PINK SALMON SCALES

R.L. MAJOR, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

A major objective of the Bureau of Commercial Fisheries' Seattle Biological Laboratory is to develop a basic knowledge about Pacific Salmon (Oncorhynchus spp.). Because no two stocks of a particular species of salmon have identical life histories, it is important to first identify the various stocks and then to collect the biological data for each stock. The objectives of this project are (1) to identify the important stocks of salmon by their scale patterns and (2) to quantitatively divide catches containing mixed stocks into their component parts.

To date, differences noted in inshore samples of sockeye salmon from Asia and Western Alaska have been used to identify fish taken on the high seas as either Asian or Western Alaskan providing that the fish are maturing and that they are taken west of 175 degree W. longitude. We continue to study scales as a means of identifying the great number of sockeye salmon stocks inhabiting the Gulf of Alaska (East of 175 degree W.) and immature salmon in all areas.

Similarly, differences noted in the scale patterns of pink salmon from several North American areas have been used to classify samples taken in the Gulf of Alaska to their area of origin.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0335, BLOOD PARASITES OF NORTHWEST FISHES

M. KATZ, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

This study is divided into two major sections. One section is devoted to the blood parasites of freshwater fish, primarily cottids found in various streams in the Green River watershed. At some stations certain cottids are infected with Cryptobia, Trypanosoma and Haemogregarina, while at other stations in the same stream the same fish species have no blood parasites or are infested with only one species. The ecological requirements of these fish, their food habits, behavioral patterns and migrations will be studied in an effort to determine the factors responsible for the variation in parasite infestation. It is hoped that an understanding will be gained of the life history of the parasite.

The second section of the project is a study of the life history, distribution of the blood fluke of the hake, Oportocotyle margolosi. The incidence of infection is being correlated with the age, sex, and size of the host fish. Large collections of hake from various locations in Puget Sound are being collected to determine the differences in distribution which may give some understanding of the life history of the parasite.

The food preferences of the hake are being studied to determine the invertebrates which may be the intermediate hosts of the nematode.

Blood smears of the hake are being examined for the presence of blood protozoans. In addition, the other helminth parasites of the hake are being enumerated to see if there is any correlation between the infestation of the blood with, and the numbers and kinds of other parasites.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0336, EFFECTS OF IRRADIATION, TEMPERATURE AND OTHER ENVIRONMENTAL FACTORS ON SALMONID EMBRYOS

A.D. WELANDER, Univ. of Washington, Graduate School, *Seattle, Washington* 98122 (AT(45-1))

This is a study of the combined effects of acute doses of X-rays on developing salmonoid embryos held at various temperatures. Fish surviving to juvenile and adult stages will be examined for morphological changes in characteristics and alterations in reproductive capacity. Macroscopic as well as microscopic examinations, especially of chromosomes, will be made. Changes in meristic characters, body proportions and color are expected to occur at certain sub-lethal doses of x-irradiation. The 'stimulation' effects of low doses will be investigated. The effects of light on embryos, which are similar in some ways to temperature and irradiation, will also be investigated.

Results to date: A study of the synergistic effects of ionizing radiation and temperature on salmonoid embryos was started October 1, 1967. Four developmental stages were irradiated in duplicate, one at ambient temperature and one 3.5 F above ambient temperature. Doses of 100 r or more caused proportionately higher mortalities at the elevated temperature. Differences in mortalities were much less after lower doses. Fish raised at the elevated temperature were 50 percent heavier and 18 percent longer. All irradiated lots raised at ambient temperatures were significantly larger than the non-irradiated controls.

SUPPORTED BY U.S. Atomic Energy Commission

5.0337, DISTRIBUTION OF C. BOTULINUM IN COMMERCIAL SMOKED FISH

E.M. FOSTER, Univ. of Wisconsin, Agricultural Experiment Sta. , *Madison, Wisconsin*

Outbreaks of type E botulism in 1960 and 1963 have been traced to smoked fish processed in the Great Lakes area. The purpose of this study is to determine the source of C botulinum type E on the fish.

Samples of water, mud and fish from various places in the Great Lakes will be tested for the presence of the type E organism to see if it occurs commonly and, if so, where it exists on or in the fish. Various species of fish will be tested to see if there is a difference in incidence between species. Efforts will be made to determine the natural habitat of the organism if it is found commonly. Concurrently, experiments will be run to evaluate methods of detecting C botulinum type E in natural materials.

SUPPORTED BY Wisconsin State Government

5.0338, SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES

A.D. HASLER, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

The investigator will determine the environmental cues and the sensory mechanisms utilized by fish to direct their migrations. An intimate understanding of the characteristics of fish movements as they occur in nature is prerequisite to critical testing of specific hypotheses. The basic approach will be to conduct research in regions of known migration and to accumulate large numbers of detailed maps of the migration pathways of the fish as they are moving through these areas. This will be accomplished through the use of the technique of ultrasonic tracking. Simultaneously several environmental factors which might be used as cues in the orientation process will be monitored during the tracking. Tracking experiments conducted under a wide variety of environmental conditions, and through the manipulation of several of the basic sensory systems of the fish, should give indications of the most important environmental cues and sensory modulities used by fish in their orientation. Laboratory experiments, concentrating on what appears to be the most important senses and mechanisms will then be initiated, along with specific field experiments, to test the most promising hypothesis of orientation.

SUPPORTED BY U.S. National Science Foundation

5.0339, SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES

A.D. HASLER, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

Brief description of research project: The investigator proposes to continue his studies on orientation of migratory fishes being conducted currently under grant GB-606. These studies have as their objective an understanding of directed movements of fishes with special emphasis upon the sensory bases of spatially oriented behavior of those fishes which undertake extensive migrations in rivers and at sea. He will extend these studies by: 1. migration of the salmon at sea, based on detailed information and techniques which were developed from a model situation in Lake Mendota, Wisconsin. 2. Continuation of studies of orientation in pond and lake fishes. 3. Studies of physiology of vision and olfaction as it relates to orientation.

SUPPORTED BY U.S. National Science Foundation

5D. MOLLUSKS - CRUSTACEA

(*see Also Food and Food Sanitation in Chapter 6a.*)

5.0340, ADULT SHRIMP STUDIES

L. BARR, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

This project began in July 1962. The shrimp industry in Alaska has increased greatly and expanded from the traditional Southeastern Alaska fishing grounds to the Seward-Kodiak area of Central Alaska. There is also a growing foreign fishery being prosecuted by Japan and USSR. There is an almost complete lack of information on the ecology of the various commercial species of shrimp in Alaska.

The commercial shrimps in Alaska all belong to the family of Pandalidae. The pink shrimp Panadalus borealis is the most important species but Pandalopsis dispar, Pandalus goniurus, Pandalus hypsinotus, and Pandalus platyeros are also harvested to some extent. The U. S. harvest of shrimp was about 30% larger in 1966 than during 1965.

The life histories of the commercial Pandalids are being studied in the Kachemak Bay area, Cook Inlet, Alaska. Sampling with 1/2 meter nets and Miller hi-speed samplers for larval shrimp and the associated zooplankton has been carried out every other week since the program began, except for times when the research vessel was inoperative. Temperature and salinity data are being taken in the bays and estuaries where the biological samples are taken.

The objectives of the current study are: (1) To determine the life histories of Pandalid shrimps in the Cook Inlet area. (2) To determine the diel behavior pattern of shrimps. (3) To determine the seasonal variation in abundance of Pandalid shrimps within restricted bays. (4) To determine the habitats of Pandalid shrimps. (5) To determine the role of nursery areas in the early life histories of the spot shrimp, Pandalus platyceros.

Most of the field work will be done in Kasitsna Bay, but some research will be conducted at Little Port Walter in Southeastern Alaska and at Auke Bay, Alaska.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0341, BERING SEA KING CRAB STUDIES

J.F. HEBARD, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

The intensified fisheries of Japan and USSR have affected the stock of king crab in the Bering Sea. During recent years, according to Japanese and Soviet catch statistics, catches per unit of effort have decreased and catches are made up of smaller crab. Currently, U. S. fishermen harvest few crabs from this area because fishing is better elsewhere. However, as the stocks south of the Alaskan Peninsula and the Aleutian Islands become fully utilized, we expect U. S. fishermen to move their operations to the Bering Sea, if the stock there is not in a depleted condition.

Systematic sampling and proven tagging methods are being employed to estimate population perimeters and the effects of fishing. These will be used to determine optimum sustainable yield. Since there is some evidence that the abundance of harvestable sized male crabs flutuates from year to year, a major portion of our research effort is directed towards determining the causes of these fluctuations. We are therefore concerned with the ecological factors that may affect growth, migrations, etc. Therefore systematic oceanographic sampling procedures are being utilized to determine water temperatures, salinities, currents, etc.

Objectives of the program include: (1) To determine the maximum sustained yield which the stock can support. (2) To develop a method of forecasting stock size. (3) To determine the distribution of the Eastern Bering Sea king crab stock with respect to abundance, shell condition, sex, and size during the period of the study. (4) To determine reproductive rates, growth rates, mortality rates, and migration patterns. (5) To determine the effect of environmental conditons on distribution, abundance, reproduction, growth, mortality, and migration on the Bering Sea king crab. (6) To compare results obtained during this study with results obtained during the previous study in 1954-1962.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0342, GULF-PENINSULA KING CRAB STUDIES

D.T. HOOPES, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

The rapidly increasing harvest of king crabs south of the Alaska Peninsula and Aleutian Islands has continued for several years. The effect of this harvest, by U.S. fishermen, on the various stocks of king crabs is unknown, partly because the geographic ranges of the separate stocks have not been determined.

Systematic sampling and proven tagging methods are being employed to estimate population parameters and the effects of fishing. The first step is to delimit the distribution of king crabs in waters of the study areas. This distributional information will then be used to define stock units. Finally, the stock units will be individually studied to make estimates of optimum yield.

Objectives of the program include: (1) To determine the relationships among inshore-offshore (national-international) populations of king crabs. To define the offshore limits of inshore stocks and to determine if completely offshore stocks exist. (2) To determine the effect of the commercial fishery on such king crab stocks and to estimate optimum fishing intensity. (3) To collect comparative data on population parameters and biology of king crabs from different geographical areas. (4) To collect oceanographic data for correlation with crab distribution and abundance information.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0343, EARLY LIFE HISTORY DECAPOD CRUSTACEANS

D.T. HOOPES, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

Most of the research on pandalid shrimps and lithodid crabs by the Bureau of Commercial Fisheries has been concerned with the population dynamics and biology of adult animals. The information available on the biology, ecology, and dynamics of the early life stages of the commercially important species of king crabs and shrimps is extremely limited. It is important that we understand these early life history stages in order to predict abundances of harvestable sized crabs and shrimps.

The objectives of this project are: (1) To describe the early life history stages of Pandalus goniurus, P. Hypsinotus, P. platyceros, and Pandalopsis dispar. (2) To determine the distribution of larval and juvenile king crab and pandalid shrimp species in respect to bottom types, depth of water, and other environmental factors. (3) To determine growth and age and size and maturity of young king crabs. (4) To determine reproductive potential of lithodid crab and pandalid shrimp species. (5) To relate environmental factors such as temperature, salinity, sediment types, associated species, etc., to abundance, growth, and natural mortality of larval and juvenile crabs. (6) To determine the energy requirements for growth, respiration, molting, and regeneration of larval and juvenile crabs; and reproduction of adult crabs. (7) To develop a method of marking small crabs.

Not all of the objectives included in this project will be worked on during any particular year because of limited funds and personnel but, since all of the objectives are important, the first objectives to be included in the field work and laboratory experiments will be those that mesh best with other Shellfish Investigation programs.

The environmental measurements such as salinity and temperature and the zooplankton data which will be collected on this project may serve as background data for other fishery or oceanographic research in the laboratory.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0344, ORGANISMS RESPONSIBLE FOR TOXICITY OF ALASKAN CLAMS

M.B. ALLEN, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

The aims of this project are: (1) to identify the organism(s) responsible for toxicity of clams and mussels in Southeast Alaska. (2) To isolate these organisms in axenic culture and study the effect of environmental variables on their growth and toxicity, with the aim of being able to predict when clams might or might not be toxic, or hopefully, eventually to control toxicity in the shellfish population.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0345, INVESTIGATION OF ECOLOGICAL FACTORS LIMITING PRODUCTION OF THE ALASKAN PANDALID SHRIMP

J.B. BEALS, State Dept. of Fish & Game, *Juneau, Alaska*

The objectives of this study are to provide life history information, ecological data, growth rates, periods of sexual reproduction, sex and species composition, bottom distribution, bottom types, length frequency data, size weight relationships, etc. of the commercially important Pandalid shrimp of Alaska. Additional collection of non-commercial species will be collected incidental to the regular sampling and will be incorporated into a key for the identification of these species. Information of fishery factors, e.g., sizes of mesh, type of trawl, duration of drags, bottom type, depth and location, etc., will also be obtained.

Sampling will consist of extracting a two to four pound sample directly from the commercial trawls after completion of a drag. Sampling will be conducted by Fish and Game Aides and Supervisory Project Leader.

Sampling will be conducted throughout the year in the Wrangell- Petersburg area and in the Kodiak Island area.

Technical personnel will include James B. Beals, Jerry McCrary and Fish and Game Aides.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0346, DUNGENESS CRAB POPULATION DYNAMICS STUDY

C.W. LEHMAN, State Dept. of Fish & Game, *Juneau, Alaska*

Objectives: To determine the effects of log rafting practices on dungeness crab grounds (preliminary investigations).

Starting in 1965 crab fishermen will be interviewed for their opinions on the effect of log rafting on crab grounds, with reference to specific instances of crab ground damage.

On the basis of these interviews, specific areas will be checked for gross changes through the use of SCUBA gear. These areas will be compared to adjacent untouched areas to assess possible damage to existing crab grounds by future log booming activities.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0347, EFFECTS OF LOG RAFTING ON DUNGENESS CRAB

C.W. LEHMANN, State Dept. of Fish & Game, *Juneau, Alaska*

Objectives: To determine the effects of log rafting practices on dungeness crab grounds (preliminary investigations).

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SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0348, KODIAK KING CRAB ENVIRONMENTAL ZONE SURVEY

G.C. POWELL, State Dept. of Fish & Game, *Juneau, Alaska*

The foremost objective of this phase of a long range study of the reproduction of king crab in the Kodiak Island area is to delineate the major environmental zones of the continental shelf near the island. The various zones will be plotted using marine charts and available trawling records so that the relative composition of the continental shelf can be related to a sampling program to facilitate the determination of possible breeding relationships. Each of the major environmental zones will be sampled so that true king crab distribution indices can be obtained. Non-feeding, non-migrating crabs will be collected as well as those actively feeding and migrating.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

5.0349, OCEAN ENGINEERING

B.F. JONES, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Juneau, Alaska* 99801

Preliminary Planning or Research: Exploratory Fishing and Gear Research general shrimp surveys have indicated substantial populations of Pandalid shrimp throughout Alaskan waters. To date, expansion of the shrimp fishery has been primarily for the pink shrimp Pandalus borealis. In southeastern Alaska, expansion of the pink shrimp fishery has been restricted primarily by the market demand, as most of the shrimp are hand-peeled for a limited high price specialty market. In other areas, the economics and processing problems are probably the most significant limiting factors. Up to this time, only minor emphasis has been placed on the development of fisheries for the prawn shrimp - Pandalus platyceros, Pandalus hypsinotus, and Pandalopsis dispar.

Utilization of Alaska shrimp stocks to date has been concentrated on small shrimp for canning and frozen 'logs' - products of low relative value having severe technological limitations. These quality problems are under study at the Bureau's Technological Laboratory at Ketchikan. Finally, quality defects resulting from vessel handling and preservation techniques are responsible for the limited scope and acceptance of present Alaska shrimp products.

Objectives: 1. To promote and assist in the development of a prawn fishery in southeastern Alaska. 2. To develop specific shrimp gear which more effectively selects and harvests the several species of Alaska shrimp. 3. To publish and release, to the fishing industry, all pertinent information as it becomes available. 4. To develop shipboard handling and preservation techniques for larger Alaska shrimp species -- shrimp primarily destined for frozen market and usually used individually. 5. To develop shipboard handling and preservation techniques for smaller Alaska shrimp species -- shrimp primarily destined for canned, block, or log products and usually used in bulk.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0350, PROCESS-INDUCED CHANGES IN CRUSTACEAN MUSCLE TISSUE

R.W. PORTER, U.S. Dept. of Interior, Technological Laboratory, *Ketchikan, Alaska*

A unique feature in processing many shellfish as contrasted with processing vertebrate animals is that the meat is cooked in the first stage to facilitate removal of the shell. Consequently, the normal post-mortem changes in the bio-chemical and physical properties of raw meat do not occur in processed shellfish. Instead, the cooked shellfish meat undergoes other changes, mainly in flavor and texture. These result from losses in flavor constituents, moisture, and many water soluble constituents. These losses are affected by pre-processing handling (crabs are held alive in salt water tanks before processing) and the initial cooking process (time and temperature).

The nucleotides of king crab have been characterized and the results will soon be published. The next phase of this study will be to alter processing conditions to allow maximum accumulation of IMP, a known flavor enhancing compound and correlate this with flavor panel scores. If these factors are directly correlated the king crab quality could benefit by incorporation of these changes into commercial processing of king crab.

In addition, cooking time and temperature will be varied to assess their effects on the losses of muscle tissue constituents following freezing and thawing. In particular we are going to check the amount of nucleotides, free amino acids and undenatured protein which is lost in the fluids freed after thawing as influenced by prior cooking time and temperature. King crab (Paralithodes camtschatica) will be used as the experimental animal, however, the principles involved will be applicable to most crustacean tissue.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0351, PREDATOR PREY RELATIONSHIPS BETWEEN ECHINODERMS AND MOLLUSCE

A.S. MARGOLIN, Phoenix College, Undergraduate School, *Phoenix, Arizona* 85013

The recognition of predators by prey species and the reactions of the prey, which in many cases, appear to function as escape mechanisms, is an aspect of the behavior of marine invertebrate animals which has not been well studied. The occurrence of a considerable number of such behavioral patterns among molluscs in the presence of echinoderms presents excellent opportunities.

It is planned to work with animals from the northern end of the Gulf of California. Molluscan and echinoderm species will be collected and checked for reactions. Field observations will be made to learn whether interacting species live together, and whether there is evidence of significant predation. The collected specimens will be maintained alive in a recirculating seawater system at Phoenix College. Responses will be observed, descriptions written, and records made by still and motion pictures. Experimental situations will be planned to determine whether actual contact is necessary or whether stimulation can occur at a distance. The nature and source of the stimulating material will be studied.

During the summers, work will be done at the Friday Harbor Laboratories to determine whether the seastar Pisasler ochraccus is repelled by the raised mantle of Diadora aspera, and if so, what the nature of the repelling substance is. Work will also be done on the effect of extracts of the seastar Pycnopodia helianthoides on the snail Buccinum plectrum.

SUPPORTED BY U.S. National Science Foundation

5.0352, TEMPERATURE NEEDS FOR GONADAL DEVELOPMENT AND SPAWNING OF DIFFERENT PHYSIOLOGICAL RACES OF THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA

V.L. LOOSANOFF, Univ. of The Pacific, Graduate School, *Dillon Beach, California* 94929

Chief aim of the proposed studies is to evaluate the differences in temperature requirements for maturation of gonads and some aspects of the spawning behavior of different physiological races of the American oyster, C. virginica. These studies will be based on the results of experiments designed to ascertain the number of days required for oysters of different geographical races, kept at different but constant temperatures, to develop the first mature sex cells, and the number of days before these oysters can be induced to spawn.

Studies are based on large samples of oysters which originated in the waters of Long Island Sound, Connecticut, New Jersey, Virginia, South Carolina and Florida.

SUPPORTED BY U.S. National Science Foundation

5.0353, THE EPICARIDEA OF THE EASTERN PACIFIC

C.G. DANFORTH, Glendale College, Undergraduate School, *Glendale, California* 91208

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

5.0354, PORCELLANID CRABS OF AUSTRALIA

J.S. GARTH, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

The Porcellanidae, a family of marine crabs belonging to suborder Anomura, are found in the littoral and sublittoral zones of all but the coldest seas. As part of a long-term revisionary study of the Porcellanidae of the world, the Co-Investigator has become involved in a series of projects dealing with Indo-west Pacific members of the family with assistance from grant NSF GB-3225.

Thirty-three species of Porcellanidae have been reported from Australia, but at least ten more, not recorded in the literature, are known to occur there; a thorough survey may reveal the presence of still others. The relationships of the porcellanid fauna of Australia with that of other areas are not fully understood, and the status of a few species is doubtful. Very little attention has been paid to the Australian Porcellanidae from the standpoint of habits and ecology. Even routine identifications are difficult in many cases because of inadequate descriptions, lack of illustrations, and scattered literature.

The object of the proposed research is to attempt to solve the problems relating to this fauna, through review of the literature pertaining to Porcellanidae of Australia, examination of Porcellanidae in several Australian museums, and collection and study of fresh material.

SUPPORTED BY U.S. National Science Foundation

5.0355, GROWTH LAYERING IN BIVALVED MOLLUSKS - AN AID IN PALEOBIOGEOGRAPHIC INTERPRETATION

C.A. HALL, Univ. of California, Graduate School, *Los Angeles - U.C.L.A., California* 90024

A systematic study of the microtexture of the same or similar year classes of Tivela stultorum will be made throughout its range. The presence of annual growth bands or rings on this species has been documented by others. (A) The mean thicknesses of the 'daily' or fourth-order layers in the second to fourth annual band will be determined. (B) The number and kind of growth layers in (i) the summer and (ii) winter (second-order layers) will be counted. The following questions will be asked: (1) Are there 360 to 365 daily or fourth-order growth layers present between the annual bands or in the first-order layer in Tivela collected at different sites and latitudes. (2) Are there differences in the thicknesses of fourth-order layers that can be correlated with latitude or some other factors. (3) Other than Tivela, which taxa have annual or seasonal growth layers and at what latitudes and in what temperatures of water do those forms with such bands occur? (4) Do taxa from high polar latitudes have slow shell growth, are there 360 to 365 'daily' growth increments as have been noted in taxa from temperate and outer tropical latitudes? (5) Do taxa from near-equator latitudes have seasonal growth bands or layers.

SUPPORTED BY U.S. National Science Foundation

5.0356, PORT SAMPLING - CRESENT CITY, BROOKINGS, PORT ORFORD

H.G. ORCUTT, State Dept. of Fish & Game, *Menlo Park, California*

The work planned for this project (January 1, 1966-June 20, 1966) is the continuation of the monitoring and sampling of landings of crab, shrimp, and bottomfish initiated in January, 1966. The work includes collecting and analysing catch and life history data for the Ports of Crescent City, Port Orford, and Brookings. The data and observations are necessary to determine changes in population size, age composition, and stock status as prerequisites to proper management of the crab, shrimp, and bottomfish resources.

1. During the period January through April, the work is primarily with the crab fishery. 2. During the period May through

June, work is primarily with the shrimp fishery. 3. During the entire period, the second priority is to monitor the otter trawl fishery at Crescent City and Brookings.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
California State Government

5.0357, SHELLFISH AND BOTTOMFISH DATA

H.G. ORCUTT, State Dept. of Fish & Game, *Menlo Park, California*

Using crab resource data, the effects of continually increasing fishing pressure, the efficiency of saving gear, the adequacy of size limits and seasons, the values of harvesting males only, the recruitment and mortality rates, the wide variations in landings, and the extended period of low yield will be studied to determine how to improve commercial fishing.

From shrimp data, the methods of population estimation, the optimum catch per shrimp bed, the season for greatest return for effort, the exhaustion of shrimp beds in one season, and recruitment and mortality rates will be studied to evaluate the fishing methods.

By study of bottomfish data, the trends of a fishery developing from one based on a few flatfish species to one of many flatfish, rockfish, hake, sablefish, and other species will be traced. The possible inter-relationships of sub-populations disclosed by tagging data will be examined. The value of savings gear in the multiple species fishery and economical means to increase the catch per unit of effort will be studied. Evidences of latent resources and discarded fish will be examined to determine need of more full utilization of fish readily taken.

The work schedule for July 1, 1966-June 30, 1967 is for the study of crab, shrimp, and bottomfish data at the Fish & Game Laboratory at Menlo Park. This includes: (1) Compilation of data on hand (2) Key- punching data for computer use and (3) Design a program for electronic data computers.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
California State Government

5.0358, SHELLFISH EMBRYOLOGY AND LARVAE DEVELOPMENT STUDY

P.M. ROEDEL, State Dept. of Fish & Game, *Menlo Park, California*

Objectives: To study the techniques of previous investigators of shellfish culture: To attend training sessions in shellfish culture methodology and procedures: To initiate laboratory and equipment designs designs for a shellfish laboratory.

Procedure: Research of shellfish culture and shellfish embryology literature will be initiated and continued. The biologist in charge will be sent to the Milford, Conn. laboratory of the U.S. Bureau of Commercial Fisheries for training in methodology and procedures. Work on laboratory design and plans for obtaining necessary equipment will be initiated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
California State Government

5.0359, SYSTEMATICS OF THE ANTARCTIC AND SUBANTARCTIC GAMMARIDEAN AMPHIPODA

J.L. BARNARD, Beaudette Fdn. Trust, *Moss Landing, California*

The primary purpose of this study is to interrelate abyssal and bathyal Amphipoda of antarctic and subantarctic seas to those of other ocean basins and to those of sublittoral antarctic depths. Sublittoral collections at hand were obtained in the Magellanic area of South America by R/S Vema and deep-sea collections were obtained from South America westward and southward by Vema and R/S El Tanin. Most of the funds are to be devoted to illustration and description of new and poorly known species in the deep-sea collections. Only benthic Gammaridea will be studied. Interrelationships will be studied particularly with those amphipodan faunas that have been well-studied: bathyal California, abyssal and bathyal north and south Atlantic, northwestern Pacific and subarctic. A secondary purpose is to determine the extent of bipolarism in Amphipoda; this is a question that is presently controversial.

SUPPORTED BY U.S. National Science Foundation

5.0360, INVESTIGATE THE CAUSE OF MORTALITY OF PACIFIC OYSTERS ALONG THE CALIFORNIA COAST

P.M. ROEDEL, State Dept. of Fish & Game, *Sacramento, California* (14-17-0001-1382)

To conduct studies of normal and abnormal oysters to determine pathological conditions and causative factors and relate these factors to mortalities.

The first phase of the project will include three weeks of specialized training to the project leader at the Bureau of Commercial Fisheries Laboratory, Oxford, Md., and at the Oyster Disease Laboratory at the University of Washington.

The next and continuing phase is the establishment of a sampling and study program. Oyster producing areas of California will be sampled monthly to determine endemic diseases, causes of mass mortalities, and survival of oysters in varying environmental conditions. This study will include the marine bays and species as indicated below: Morro Bay-Crassostrea gigas; Elkhorn Slough-C. gigas; Drakes Estero-C. gigas; Tomales bay-C. gigas, C. virginica; Humboldt Bay-C. gigas, O. lurida

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0361, ECOLOGICAL, EXPERIMENTAL AND COMPUTER STUDIES OF ENDOGENOUS RHYTHMICITY

J.T. ENRIGHT, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

This proposal requests support for research on endogenous physiological rhythmicity in marine crustaceans. The research involves three general lines of approach: 1) laboratory experimentation designed to evaluate the sensitivity of tidal and circadian rhythms of crustaceans to phase-shifting by mechanical stimuli, light and chemicals; 2) laboratory and semi-controlled field experimentation to determine the relationships between rhythmicity in locomotor activity and orientation to light stimuli; and 3) computer studies to extend, refine and test a mathematical model for endogenous rhythmicity in locomotor activity, a model which is based on the hypothesis that simple couplings between elements of the central nervous system underlie the rhythms.

SUPPORTED BY U.S. National Science Foundation

5.0362, STUDIES IN MICRONEUROPHYSIOLOGY

S. HAGIWARA, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038

Membrane mechanisms as well as excitation contraction coupling in giant muscle fibers in a barnacle will be studied by using voltage clamp technique, ion flux measurement, etc. Similar lines of work will also be done in multi-ionic mechanisms of Aplysia ganglion and photo receptor cells in a barnacle.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0363, THE STRUCTURE AND FUNCTION OF CRUSTACEAN EYES

E.M. KAMPA, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The eyes of crustaceans that inhabit the open ocean and undertake extensive diurnal vertical migrations differ vastly in structure, developmental pattern, photomechanical changes, pigments and spectral sensitivity from those of inshore bottom-dwellers. In certain pelagic crustaceans, development is an outward growth of retinular cells which secrete a hyalin filament distal to the rhabdom. This filament acts as a light guide and ommatidia. Other pelagic forms examined recently have structures homologous with the bottom-dwellers, but show no photomechanical changes in screening pigment. Examination of histological preparations indicates that in these a light guide may be occasioned by a modification of the proximal section of the cone stalk. All of the Crustacea that have so far yielded to spectral sensitivity studies (by electroretinograms) or to visual pigment extraction show a marked adaptation to photoenvironment. During September-December, 1965, we examined intensively the photoenvironments, vertical distribution and spectral sensitivities of animals in the upper 1000 meters of water in a selected small area of ocean. Specimens were also preserved for histological analysis. It is the purpose of the proposed project to correlate the various facets of the investigation and to evaluate critically the hypothesis that environment may exert as considerable an influence on the structure and function of crustacean eyes as do phylogenetic relationships.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0364, RESEARCH ON THE BIO-SYSTEMATICS OF THE CIRRIPEDIA

W.A. NEWMAN, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The proposed research concerns aspects of the biosystematics of the thoracic Cirripodia. Four areas of inquiry are to be followed, dealing with 1) recurrent setation patterns in larval forms, 2) development and significance of interlaminate figures, 3) function of primordial plates in the Lopadomorpha during metamorphosis, and 4) a possible functional relationship between the eyes of balanomorphs with certain so-called ornamentations of the shell.

SUPPORTED BY U.S. National Science Foundation

5.0365, GENETIC REGULATION OF HEMOGLOBIN SYNTHESIS IN ARTEMIA

S.T. BOWEN, San Francisco State College, Graduate School, *San Francisco, California* 94132

The long-term goal of this research is to elucidate the role of structural and regulator genes in the synthesis of hemoglobin in the brine shrimp, Artemia salina. This may be an excellent system for the study of regulator genes in a metazoan because Artemia hemoglobin is an inducible protein which can be readily isolated and characterized and it occurs in a species which is suitable for intensive genetic studies. Shrimps mature in two weeks, making it possible to obtain more than 12 generations in one year. Females produce broods of about 50 nauplii every 6 days throughout their life span of 4-6 months. Of the nine single-locus mutations reported in this species, six have been found in our laboratory. Because Artemia races, when reared in the laboratory, initiate hemoglobin synthesis at different levels of oxygen deprivation, it is possible that they differ in regard to regulator genes.

There are three specific objectives: 1) We plan to determine which environmental factors are needed for maximum synthesis of each of the three hemoglobins. 2) We will determine the mode of inheritance of the three hemoglobins commonly found in wild populations in salterns on San Francisco Bay. More than 100 shrimps have been examined and it is evident that the hemolymph of one shrimp may contain any one hemoglobin, a combination of any two, all three homoglobins, or none at all. There is a sex difference in the distribution of hemoglobins in the wild population. Hemoglobin synthesis will be studied in the progeny of single pair matings in our laboratory stocks which carry a marker on the sex chromosome and in which crossing over is suppressed between the sex chromosomes. 3) We will characterize the hemolymph chromoproteins by dissociation into subunits, determination of molecular weights, and (if time permits) by fingerprinting and amino acid analyses.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0366, THE PROCESS OF DEMINERALIZATION-BORING IN BIVALVES

E.H. SMITH, Univ. of The Pacific, Graduate School, *Stockton, California* 95204

The proposed research would involve a detailed morphological and ecological study of the species which employ a process of chemical demineralization to aid in boring into calcareous substrates. After the initial morphological study the demineralization research program would be divided into three parts. First, the actual demineralization process used in softening calcareous rocks or shells would be investigated. This would include the histology and histochemistry of the organ or organs systems involved, along with a functional interpretation of the actual process. The histology and histochemistry of the secretion and formation of the periostracum would be studied in detail. Lastly, the process of lining the burrow with a calcareous matrix would be investigated. This proposed research program would shed light on the mechanisms used in demineralization and decalcification by marine organisms, calcification mechanisms and make up, and the role of the protective periostracum.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0367, SYSTEMATICS, BIOLOGY, AND HYDROGRAPHIC RELATIONS OF SOME SPECIES OF CALANUS (CRUSTACEA, COPEPODA)

B.M. BARY, Univ. of British Columbia, Graduate School, *Vancouver - British Columbia, Canada*

This research is concerned with a definitive analysis of the distribution and morphological variation of the copepod genus Calanus, an animal which occupies a primary position among planktonic populations; often dominating a community and covering large areas of the upper sea layers. The investigator is attempting to determine the hydrographic water mass factors which support and/or limit the distinct populations of this animal.

An understanding of the biological and ecological factors that influence distribution of organisms is essential in hydrobiological studies. With information gained from these kinds of studies predictions can be obtained relating to the dispersal and occurrence of pelagic forms of boring and fouling organisms, those capable of acoustic interference and/or luminescence, and those forms which constitute toxic hazards to personnel.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0368, COPEPOD CRUSTACEANS PARASITIC ON FISHES

A.G. LEWIS, Univ. of British Columbia, Graduate School, *Vancouver - British Columbia, Canada*

The purpose of the project is to study the collections of copepod fish parasites from Eniwetok Atoll and from Indian Ocean fishes both from a taxonomic and a zoogeographic standpoint. The hydrographic data from cruise 2 of the Anton Bruun will be used in the dicussion of the distribution of the copepod parasites of the pelagic fishes collected during this cruise. The distribution of these copepods, as well as others collected during cruise 2, will be compared with their distribution throughout the world.

SUPPORTED BY U.S. National Science Foundation

5.0369, ION TRANSPORT MECHANISM IN GIANT AXON

E. ROJAS, Univ. De Chile, *Santiago, Chile*

I. A parallel study between biochemical properties of the enzyme system ATP-ase isolated from cell membrane fraction of the squid giant axons and transport of sodium, potassium and calcium ions by giant axons under continuous intracellular perfusion.

II. A parallel study between ion-exchange properties of the cell membrane fraction and ion-exchange properties of the axonal membrane under continuous intracellular perfusion.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0370, ECOLOGY OF MARINE BIVALVE MOLLUSCAN LARVAE

T.A. GAUCHER, General Dynamics Corporation, *Groton, Connecticut* (N00014-66-C-0302)

This program is a study of the causative mechanisms which may explain why larval molluscs, specificially Mya arenaria, are found in clustered, discontinuous distributions. The ecosystem of which the larval mollusc is a part is being examined for the possible effects of intraspecific behavior, mass mortality, and hydrographic factors upon the site of attachment of these molluscs. In addition, the hypothetical exhibition of preference by molluscs of one substratum type over another on which to set is being examined and evaluated.

One of the most interesting biological problems faced by Navy planners concerns the ability of artifacts placed in the sea to attract organisms. The proposed study explores the problem and relates especially to the behavior of sessile and burrowing animals, including boring, fouling, and the undercutting of bottom sediments on which equipment is resting. Since the Navy is moving more and more towards operations requiring long-term submergence, it is desirable to examine this attraction in an attempt to avoid or control it.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0371, LARVAL STUDY OF THE LOBSTER

W.A. LUND, State Board of Fish. & Game, *Hartford, Connecticut*

Plankton tows will be taken in Long Island, Fishers Island, and Block Island Sounds in the Atlantic Ocean off Block Island and Long Island in an attempt to locate larval lobsters. A few tows taken during 1965 have been examined for larval lobsters. Some larvae were collected in the Sounds, but better results were obtained in the Atlantic off Montauk.

Information available from the former Lobster Hatchery at Naank, Connecticut, indicates that the majority of lobster eggs hatched in June and early July. It is proposed to closely observe egg development on buried females during the spring. This can be accomplished by fishing our own pots or by sailing with certain commercial lobsterman.

Weekly plankton tows will be initiated in the inshore waters during the latter part of May. The periodicity and duration of the tows will be increased as information is gathered. Day and night tows will be made to evaluate which is the better time to sample. Only surface tows will be made during 1966.

Offshore plankton tows are believed to be necessary if we hope to delineate the population to which the Fishers Island and Long Island Sound lobsters belong. It will be necessary to determine the areas of origin, the transport of the larvae and the probable areas of settlement before we are able to understand the ecology of this animal in this area. An off-shore cruise made on August 5, 1966, yielded six lobster larvae (three 1st stage, one 3rd stage and two 4th stage). The area sampled is approximately 40 to 55 miles SSE off Montauk, Long Island. This is the only evidence we have on the occurrence of larvae in the Atlantic off Block Island and Long Island. Periodic cruises will begin in June and continue until additional positive evidance is gathered on the offshore occurrence of the larvae.

Part 1 of 3.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Connecticut State Government

5.0372, TAGGING PROGRAM

W.A. LUND, State Board of Fish. & Game, *Hartford, Connecticut*

The major emphasis on this phase will not take place until 1967 and 1968. It is believed that basic information of the size composition and distribution of the population is needed prior to the initiation of this phase.

The type tag to be used will not be selected until other researchers have completed their evaluation of tags and methods of attachment.

Objective: 1. Determine the movements of lobsters in and from Long Island and Fishers Island Sounds. 2. Define the population to which these lobsters belong. 3. Determine the rate of exploitation.

Procedure: It is planned to use three procedures for securing lobsters. These are: 1. Scuba divers collecting and tagging under water. 2. Fish our own pots. 3. Buy directly from the lobster boats.

It is believed that divers will be able to collect lobsters more efficiently than with any type gear. Experience to date indicated that smaller lobsters are easily found in daytime, but larger lobsters are more accessible at night. The additional advantage of using divers is that more accurate information can be gathered on local movements by revisiting areas previously worked.

We plan to fish a rather limited number of pots in an attempt to evaluate the most efficient method of catching lobsters. These pots must be unbuoyed and checked by divers. Experience has shown that the probability of byoyed pots being disturbed is extremely high.

Several lobster fishermen have promised complete cooperation in this program. It is planned to secure lobsters, tag and release them in areas not accessible to divers. These areas are, in general, deep and have fast currents. This procedure will be discontinued if returns indicate extensive movements of lobsters from shallow to deep waters.

Part 3 of 3.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Connecticut State Government

5.0373, PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM)

H.C. DAVIS, U.S. Dept. of Interior, Biological Laboratory, *Milford, Connecticut*

The development of routine methods for rearing bivalve larvae has enabled us to determine the effect of various ecological factors on larvae of the American oyster, Crassostrea virginica, and the hard clam, Mercenaria mercenaria. Studies have been made of the effect of the type and quantity of food, salinity, temperature, turbidity, pH, and of various pesticides and detergents on embryonic development and on growth of the larvae of these two species. In some studies we have observed the combined effect of varying two or more of these factors simultaneously.

We are currently experimenting to determine the pH range for spawning of oysters and the effect of the pH at spawning on viability of the sperm and eggs. We are also currently studying the effect of keeping oysters at lowered salinities, during gonad development and spawning, on subsequent embryonic development and larval growth at different salinities. We expect to soon have methods developed for studying the behavior of larvae and the effect of light, gravity, temperature, salinity and currents on the behavior of larvae of different ages and sizes. Such studies are urgently needed to develop an informational basis for field work on distribution of larvae.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0374, ECOLOGICAL FACTORS AFFECTING REPRODUCTION OF SHELLFISH (PHYSIOECOLOGY OF SHELLFISH PROGRAM)

H.C. DAVIS, U.S. Dept. of Interior, Biological Laboratory, *Milford, Connecticut*

This project has developed largely in an attempt to discover the origin and distribution pattern of the oyster larvae that set in Long Island Sound. Studies of the intensity of setting in the Bridgeport- Milford -New Haven area have shown that, while certain sections are more likely to get a heavier set than others, setting is usually very spotty, i.e., some sections may get a heavy set while nearby sections receive almost none at all. Plankton samples have shown that, even during the spawning season, oyster larvae are not numerous and that the earlier stages, 75-250 microns in length, are rarely encountered. The 250-325 micron larvae appear suddenly in the plankton samples and setting starts immediately.

At present we are attempting to locate the 'nursery areas' where these larvae develop to the 250-325 micron stage before they appear in Long Island Sound. Once these 'nursery areas' have been discovered, we shall attempt to determine the attributes that enable the larvae to develop there and to increase recruitment by replenishing the spawning stock in these areas.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0375, HYBRIDIZATION STUDIES ON THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA (GENETICS OF SHELLFISH PROGRAM)

A.C. LONGWELL, U.S. Dept. of Interior, Biological Laboratory, *Milford, Connecticut*

It might be expected that the effects of heterosis in the American oyster, Crassostrea virginica, would be inversely proportional to the additive gene variance of different traits. Such estimates of heritability are underway.

Trial hydridizations between numerous local and non-local American oyster populations are being made as tests for heterosis, and for desirable combinations of characteristics displayed by oysters from different ecological conditions. Numerous inbreeding lines shall be test-crossed in the F3 for heterosis. Breeding plans have been made for determining the merit of reciprocal recurrent selection for devloping the combining ability of parent oysters used for making hybrids. By selection of each generation of oysters on the ability of individuals to cross well with each other oyster group, strains of oysters might be improved in their ability to produce hydrid vigor when crossed with each other.

The similarity of the chromosomes of six species of oysters of two different genera indicate that there may be no gross chromosomes barrier to the production of fertile species hybrids. Chromosome ananlysis of hybrid eggs could provide important clues as to the evolutionary relationships of our present-day commercial and non commercial oysters.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0376, SELECTIVE BREEDING OF THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA (GENETICS OF SHELLFISH PROGRAM)

A.C. LONGWELL, U.S. Dept. of Interior, Biological Laboratory, *Milford, Connecticut*

Sexual reproduction in the American oyster, Crassostrea virginica, occurs with the usual genetic recombination and crossing-over. There are ten gene linkage groups. Its outbreeding system can be affected by protandry, hermaphroditism, alteration of sex and parthenogenesis. Experimental lines of American oysters are being bred by sib-matings for, among other purposes, estimating the amount of inbreeding in the wild.

Heritability estimates are being made of commercially important traits with attendant predictions of annual progress by selection. Phenotypic and genetic correlations are to be made between commercial characters with the ultimate intention of establishing a selection index. Current emphasis is on growth rate for which two-way selection experiments are to be set up. Outcrosses to increase genetic variance are being made prior to long-range selection of commercial strains.

Mutation studies have been initiated in C. virginica using ionizing radiation and chemical mutagens. The purpose of this work is to (1) obtain useful, marker gene and chromosome mutants, and commercially valuable mutations; (2) test the value of mutation breeding in the mollusks; (3) establish background information essential to future work, such as the transposition of chromatin following radiation-induced chromosome breakage for transfer of specific characters from a non-- commercial to a commercial oyster.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0377, NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM)

C.L. MACKENZIE, U.S. Dept. of Interior, Biological Laboratory, *Milford, Connecticut*

Because of a scarcity of seed oysters in Long Island Sound, more efficient control of predators and competitors becomes imperative.

Control of oyster drills and starfish has been achieved. To make control methods more efficient, however, we are presently studying various aspects of the biology of both predators. Particular emphasis has been placed on studying feeding rates of each at various salinities and temperatures, and also on the behavior of these and other enemies on oyster beds as observed by SCUBA divers.

Divers have observed that young starfish hid underneath shells during the day. We are presently attempting to determine the reason they do this.

To better equip the shellfish producer to apply more efficient control methods for Stylochus, Crepidula and barnacles, the principal competitors of oysters, we plan to study various stages of their life cycles.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0378, METHODS OF CONTROL OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM)

C.L. MACKENZIE, U.S. Dept. of Interior, Biological Laboratory, *Milford, Connecticut*

In Long Island Sound, the chemical Polystream is now used routinely by oyster companies to control oyster drills on their seed beds. Losses owing to predation by oyster drills have been reduced to less than 2 percent a year. Companies using lime to control adult starfish and Polystream to control oyster drills lose less than 10 percent of their oysters a year to these predators.

We have discovered that there is no 'winter kill' of oysters. Actually, a layer of silt which settles over a bed during the winter smothers oysters near the bottom when they become active in April and May. Losses range from 0 to 50 percent. In 1968, most oyster companies transplanted their seed in March and early April to avoid silting losses.

By controlling predators and avoiding spring silting losses, companies have reduced overall losses of young seed oysters from 99% to 70%, and of one-year-old oysters from 90% to 30%, thereby increasing yields from 1 to 1, to 10 or 15 to 1.

Presently, we are studying ways to reduce losses even further. The largest losses result from (1) Crepidula which smother young oysters, (2) smothering against the bottom, and (3) mechanical breakage while dredging.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0379, STRUCTURE AND FUNCTION OF EYES

W.H. MILLER, Yale University, School of Medicine, *New Haven, Connecticut* 06520

The proposed investigation is to study the neural structure of primitive eyes and its relation to their function where that function is known. Where it is unknown the functional organization will be investigated using electrophysiological means.

In particular, for the anatomical part of this study, synaptic interrelations between neural elements will be investigated (1) in the compound eye and optic ganglion of the horseshoe crab, Limulus, where the relations between structure and the inhibitory interaction in the eye and structure and the complex neural responses of the optic ganglia will be investigated; (2) the eyes of the scallop, Pecten, where the relation between structure and the 'off' response will be explored; and (3) the frontal organ (third eye) of the frog, Rana, where the relation between structure and the excititory and inhibitory optic nerve responses will be studied. For the physiological studies the electrical responses of single ganglion cells of the frog's frontal organ will be investigated to determine as yet unknown functional properties of the receptive fields of these cells.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0380, CALORIC STUDIES OF SPARTINA AND THE MARSH CRAB SESARMA RETICULATUM

F.C. DAIBER, State Board of Game & Fish, *Dover, Delaware*

Objective: To evaluate the energy transfer from the marsh grass Spartina alterniflora through the marsh crab Sesarma reticulatum.

Procedures: For the past several summers we have been gathering life history information on one of the important inhabitants of our tidal marshes, the marsh carb Sesarma. These studies have included food habit studies and estimates of population densities. The marsh grass Spartina is an important item in the diet of this crab. We have estimates of production of this grass during the growing season.

The individual crabs that are not carrying egg masses and preferably males will be weighed and then placed in containers where they can keep their gills moist but can get out of the water. Temperature will be maintained at 20 degrees C. Each crab will receive weighed portions of fresh grass. Each 24 hour period the grass remaining in the container will be weighed and replaced with fresh grass. The fecal pellets will be collected each 24 hour period, dried, weighed and prepared for the bomb calorimeter.

Subsamples of the crabs will be weighed, sacrificed, dried to constant weight and prepared for the bomb calorimeter shortly after returning from field collecting. Those crabs that have been fed grass in the laboratory will be reweighed after one week of feeding, sacrificed and prepared for the bomb calorimeter.

This procedure will yield the following information -- (1) total energy in the grass, (2) energy ingested, (3) energy consumed in respiration, (4) energy egested in the feces and (5) energy going into new crab flesh. This data will give a measure of gross growth efficiency new protoplasm per unit time energy consumes as well as net growth efficiency energy consumed - energy egested per unit time for the crab.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Delaware State Government

5.0381, LOCATING AND MAPPING THE EXISTING SEED OYSTER BEDS IN DELAWARE BAY

T.P. RITCHIE, State Comm. on Shell Fisheries, *Dover, Delaware* 19901

The excellent report and map of the seed oyster beds which was prepared by Moore in 1910 will be used as a guide in locating and evaluating the extent of the existing seed oyster beds in Delaware Bay. The peripheral boundaries of each existing natural oyster bed will be located and marked with the aid of a commercial oyster dredge boat. Sextant and/or radar hearings will be taken at several locations on each natural oyster bed. The outline of each natural oyster bed will be ascertained by stakes and buoys. Accurate measurements of the total area of each oyster bed will be made.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Delaware State Government

5.0382, BIOLOGICAL EVALUATION OF EACH EXISTING SEED OYSTER BED IN DELAWARE BAY

T.P. RITCHIE, State Comm. on Shell Fisheries, *Dover, Delaware* 19901

The objective of this phase is to make a thorough biological examination of each individual natural seed oyster bed. Bottom samples will be collected by using a special oyster sampling dredge of measured width. The sampling dredge will be pulled along selected transits for a specified distance or time. All of the material dredged up will be examined in order to determine the ratio of oysters to shells. The total number of the various sized oysters in each sample will be counted. The relative abundance of oyster preditors and fouling organisms will be noted. Relative oyster density per square yard and per square acre can be determined by simple calculation.

Part 2 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Delaware State Government

5.0383, SHELLFISHERIES RESEARCH

D.L. MAURER, Univ. of Delaware, Graduate School, *Newark, Delaware* 19711

The purpose of this investigation is to study the life history and fluctuations of commercially important shellfish, e.g., the oyster, blue crab, hard clam, etc. This research deals with those aspects of the biology, ecology, environment of shellfish, and methods of increasing the shell fisheries crop yields. Top priority has been given to research upon propagation of disease resistant strains of oysters. MSX disease and its relation to salinity has been studied, but at present there is insufficient data to be able to draw any conclusions. Studies to anticipate the time of maximum spawning of the oyster have also been started to determine the most opportune time to plant the oyster cultch. This information will be invaluable for local shellfishermen, but will take time to determine. An oyster survey of the Delaware Bay region has been undertaken to determine the extent and condition of natural oyster beds.

SUPPORTED BY Delaware State Government

5.0384, ABYSSAL AND BATHYAL SYNOPIIDAE OF WORLD

J.L. BARNARD, Smithsonian Institution, *Washington, District of Columbia* 20560

This project, supported originally by an NSF Grant (GB 3285), commenced as a taxonomic appraisal of this family (and many others) in Antarctic Seas. Synopiids (tironids) have proved to be a diverse deep-sea faunule poorly explored and worthy of extensive study. The family will be treated in its entirety including the few sublittoral species in order to illuminate general problems of deep-sea speciation, endemism and pandemism to whatever degree they prove to be determinable. Numerous materials (Antarctica, Mesoamerica, Oregon and Bermuda transects, New Zealand, IIOE) and others available through 1970 will be treated. In 1966 the family comprised 46 spp. in 11 genera. Revision of 14 genera at least is required and MS for 30 new spp. is already in hand and being amplified steadily.

SUPPORTED BY Smithsonian Institution

5.0385, OSTRACODA OF THE INDIAN OCEAN

R.H. BENSON, Smithsonian Institution, *Washington, District of Columbia* 20560

Taxonomic description and biogeographic mapping of the Recent podocopid ostracode fauna of the Indian Ocean as a basis for future exploration of the fossil faunal provinces.

SUPPORTED BY Smithsonian Institution

5.0386, ABYSSAL OSTRACODES OF THE WORLD

R.H. BENSON, Smithsonian Institution, *Washington, District of Columbia* 20560

Description and biogeographic mapping of the Cytheracean ostracodes occurring below 500 meters in the world ocean and their history as recorded as fossils in sediment cores.

SUPPORTED BY Smithsonian Institution

5.0387, HYPERIID AMPHIPODS FROM THE GULF OF GUINEA

T.E. BOWMAN, Smithsonian Institution, *Washington, District of Columbia* 20560

Analysis of hyperiid amphipods collected by Crosnier in the Gulf of Guinea and the relationship of distribution patterns to oceanographic variables.

SUPPORTED BY Smithsonian Institution

5.0388, RELICT COPEPODS FROM LAKE TUBORG, ELLESMERE ISLAND

T.E. BOWMAN, Smithsonian Institution, *Washington, District of Columbia* 20560

Identification and enumeration of 2 spp. of calanoid copepods collected in a plankton tow in partly brackish Lake Tuborg. Both species are not now known from coastal waters of the Canadian Arctic islands, and are believed to be relicts of a formerly more widespread brackish water fauna now restricted mainly to Siberian Arctic coastal waters. Suggestions concerning their origin in Lake Tuborg are given, using information on the age of the lake determined by C14 dating of the lake water carbonates.

SUPPORTED BY Smithsonian Institution

5.0389, COPEPODS PARASITIC ON NEEDLEFISHES

R.F. CRESSEY, Smithsonian Institution, *Washington, District of Columbia* 20560

In connection with a revision of the fish family Belonidae Dr. Collette has collected many parasitic copepods. In order to further understand the biology of needlefishes I am studying their copepod parasites for possible insights into the ecology and phylogency of the hosts.

SUPPORTED BY Smithsonian Institution

5.0390, RELATIONSHIP BETWEEN WATER TEMPERATURE AND SIZE OF PARASITIC COPEPODS

R.F. CRESSEY, Smithsonian Institution, *Washington, District of Columbia* 20560

Preliminary evidence indicates a relationship between surface temperature of the water at the station from which parasitic copepods are collected and the size of the adult copepod when collections of the same species of copepod from the same species of host from different stations are compared. Possible implications as to the biology of the hosts are being investigated.

SUPPORTED BY Smithsonian Institution

5.0391, COPEPODS PARASITIC ON SHARKS OF THE WEST COAST OF FLORIDA

R.F. CRESSEY, Smithsonian Institution, *Washington, District of Columbia* 20560

To collect the shark copepods of this region with their subsequent description and/or redescription as appropriate. The Cape Haze Marine Lab., Sarasota, Florida will serve as a focal point for this project.

SUPPORTED BY Smithsonian Institution

5.0392, SYSTEMATICS OF CALIGOID COPEPODS

R.F. CRESSEY, Smithsonian Institution, *Washington, District of Columbia* 20560

Systematic survey of all caligoid copepods with emphasis on revision of families and/or genera as appropriate. This is a long term project designed to continue for several years with special emphasis on those forms parasitic on pelagic fish (sharks and tuna like fishes).

SUPPORTED BY Smithsonian Institution

5.0393, LIFE HISTORY OF THE SHARK COPEPOD, KROYERIA DISPAR

R.F. CRESSEY, Smithsonian Institution, *Washington, District of Columbia* 20560

To rear and study in the laboratory the development stages of Kroyeria dispar. Laboratory rearing of this animal to be done at the Cape Haze Marine Lab., Sarasota, Florida. Kroyeria dispar is a common parasite on the gills of the tiger shark, Galeocerdo cuvier. Development stages of caligoid copepods are poorly known. The larval stages may reveal phylogenetic affinities within this group of parasites.

SUPPORTED BY Smithsonian Institution

5.0394, SYSTEMATIC STUDY OF MYODOCOPID OSTRACODS OF THE INDIAN OCEAN

L.S. KORNICKER, Smithsonian Institution, *Washington, District of Columbia* 20560

Description and illustration of myodocopid ostracods of the superfamily Cypridinacea (mostly benthonic forms) collected during the International Indian Ocean Expeditions by U. S. ships.

SUPPORTED BY Smithsonian Institution

5.0395, STOMATOPOD CRUSTACEA FROM THE WESTERN ATLANTIC

R.B. MANNING, Smithsonian Institution, *Washington, District of Columbia* 20560

To review the 67 species of stomatopod crustaceans occurring in the western Atlantic, with full accounts of each species.

SUPPORTED BY Smithsonian Institution

5.0396, NEPHROPID LOBSTERS OF THE WESTERN ATLANTIC

R.B. MANNING, Smithsonian Institution, *Washington, District of Columbia* 20560

To review 11 of the 12 species of lobsters known from the western Atlantic; the Maine lobster, Homarus americanus, will not be included. Material for the study is available from the extensive field collections of the Bureau of Commercial Fisheries from the Gulf of Mexico and the Caribbean. Collections now available include one new genus and species. All species will be illustrated in detail and compared with species from other areas. Biological records available from BCF data bank will be included.

SUPPORTED BY Smithsonian Institution

5.0397, STOMATOPOD CRUSTACEA OF THE EASTERN PACIFIC REGION

R.B. MANNING, Smithsonian Institution, *Washington, District of Columbia* 20560

A review of the approximately 35 species of stomatopod crustaceans occurring in the eastern Pacific region to accompany studies on the stomatopods of the eastern and western Atlantic.

SUPPORTED BY Smithsonian Institution

5.0398, A BIBLIOGRAPHY OF THE MARINE MOLLUSKS OF THE INDO-PACIFIC REGION

H.A. REHDER, Smithsonian Institution, *Washington, District of Columbia* 20560

This project, originally started as an integral part of my project on Polynesian malacology, is now listed as an independent project for obvious reasons.

Each publication dealing with Indo-Pacific mollusks - whether descriptive, faunal, taxonomic, morphological - is entered in a Royal- McBee Keysort Card, and the relevant information punched out on each card.

In addition to papers dealing strictly with the Indo-Pacific marine fauna publications dealing with the classification, morphology and physiology of molluscan groups found in the Indo-Pacific region are also included.

As this bibliography approaches completion, its value as a research tool will increase in that a worker can sort out the relevant literature for any geographical area and/or any particular group of mollusks. He will also be able to dig out with relative ease the information available on any phase of the physiology or morphology of any group of mollusks. It is planned to investigate the possibility of converting this card system to a more rapid scanning system.

The preparation of this bibliography is being carried out by a technical assistant under the supervision of the principal investigator.

SUPPORTED BY Smithsonian Institution

5.0399, THE CEPHALOPODS OF THE CENTRAL PACIFIC

C.F. ROPER, Smithsonian Institution, *Washington, District of Columbia* 20560

A faunistic study of the cephalopods of the Central Pacific is being conducted in conjunction with the Pacific Ocean Biological Survey Program. The distribution and the regional and seasonal abundance of the species in relation to oceanographic parameters are being worked out.

SUPPORTED BY Smithsonian Institution

5.0400, THE SYSTEMATICS AND DISTRIBUTION OF THE WORLD-WIDE SQUID FAMILY BATHYTEUTHIDAE

C.F. ROPER, Smithsonian Institution, *Washington, District of Columbia* 20560

The systematic problems in the Bathyteuthidae are worked out. The geographical and bathyal distributions in relation to biological and oceanographic parameters are presented. The regional and seasonal abundance and the life histories of the species are shown. This work is in the final stages of manuscript and will be submitted to the publisher (Anarctic Research Series) in FY67.

SUPPORTED BY Smithsonian Institution

5.0401, SYSTEMATIC REVISION OF THE FAMILY PERIPLOMATIDAE

J. ROSEWATER, Smithsonian Institution, *Washington, District of Columbia* 20560

The classification of the family Periplomatidae is being revised. Generic groups are being reconsidered and information will be given concerning the systematics and zoogeography of this group.

SUPPORTED BY Smithsonian Institution

5.0402, SYSTEMATIC STUDIES ON MOLLUSKS FROM WALTERS SHOALS, INDIAN OCEAN

J. ROSEWATER, Smithsonian Institution, *Washington, District of Columbia* 20560

5. LIVING SYSTEMS (NON-HUMAN)

During the International Indian Ocean Expedition 1964, a collection of mollusks was obtained from Walter's Shoals, south of Madagascar. This locality is essentially an isolated sea mount. The mollusks will be classified and studied to determine their systematic and zoogeographical relationships. In view of the unique locale, the results may yield interesting information on species distribution in the Indian Ocean.

SUPPORTED BY Smithsonian Institution

5.0403, EASTERN PACIFIC SHRIMPS OF THE GENUS PENAEUS

I.C. CANET, U.S. Dept. of Interior, Systematics Laboratory, *Washington, District of Columbia* 20560

Investigations of the systematics and geographical and bathymetrical distribution of Penaeus shrimps from Pacific America, where 5 species are known to occur. This will include biometric studies to determine ranges of variations and their spatial distribution, full descriptions, and illustrations of each shrimp. Findings related to ecology and life history are being critically reviewed and summarized.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0404, BENTHIC PENAEID SHRIMPS (OTHER THAN PENAEUS) FROM THE WESTERN ATLANTIC

I.C. CANET, U.S. Dept. of Interior, Systematics Laboratory, *Washington, District of Columbia* 20560

Investigations of the taxony and distribution of benthic penaeid shrimps (other than Penaeus) collected by the research vessels Oregon, Silver Bay and Calypso on the continental shelf of eastern North America, Central America and South America. The collections appear to contain at least 16 genera and 45 species. The work will include descriptions and those illustrations necessary for the proper understanding of each taxonomic category.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0405, DIAGNOSTIC CHARACTERS & DEVELOPMENT OF EXTERNAL GENITALIA IN JUVENILE GROOVED SHRIMPS OF GENUS PENAEUS FROM WESTERN ATLANTIC

I.C. CANET, U.S. Dept. of Interior, Systematics Laboratory, *Washington, District of Columbia* 20560

Studies of the characteristics and development of the external genitalia in juvenile 'grooved shrimps' (consisting of 2 species and 4 subspecies) of the genus Penaeus from the western Atlantic. Much attention has been accorded to juvenile growth ecology, habits, movements, and tolerances to temperature and salinity; however, little progress has been made in ascertaining their identification. The peculiar characters of the petasma of the males and the thelycum of the females of each taxon at various body lengths will be listed in Tables and illustrated. Continuing.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0406, AN ANALYSIS OF DEVELOPMENT IN ARTEMIA SALINA EMBRYOS

J.S. CLEGG, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

A study is being made of the regulation of protein and RNA synthesis in the embryos of Artemia salina, a crustacean. The emphasis is placed on analysis of polysomes and ribosomes by sucrose gradient density centrifugation, on the various species of RNA present, on the incorporation of radioactive precursors into RNA and protein, and on in vitro protein synthesizing systems. Some work is also being done on lactic dehydrogenase isozymes, and on ultrastructural changes which occur during development. Particular attention is being paid to a period in the development of these embryos during which embryonic differentiation occurs in the complete absence of cell division.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0407, IONIC REGULATION IN THE QUEEN CONCH, STROMBUS GIGAS LINNAEUS

C. LITTLE, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

The proposed work is an investigation of the composition of the blood of the queen conch, and of the relations that this composition bears to that of the seawater in which the conch lives. When this basic knowledge is acquired, it is intended to examine the mechanisms by which these relations are maintained; or in other words to examine the various routes by which salt, water and possibly nitrogenous matter enter and leave the body, and to try to decide what factors exercise control over these exchanges. The three sites of exchange to be examined in detail are the kidney, the alimentary canal and the single ctenidium; but the possibility of exchange through the general body surface and through aecretions will also be examined.

SUPPORTED BY U.S. National Science Foundation

5.0408, SYSTEMATIC STUDIES ON HERMIT CRABS AND OTHER DECAPOD CRUSTACEANS

A.J. PROVENZANO, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

The marine decapod Crustacea constitute one of the most important orders of invertebrates in the sea. Many of them such as shrimps, lobsters and crabs are exploited directly by man as food species, but the group is vastly more important in the general economy of the sea as food for other organisms, especially fishes. Most decapod crustaceans have pelagic larval stages which serve to distribute the younger generation. It is these larval forms which play an important role in marine food chains, perhaps more important in some ways than the adults.

It is planned to continue studies on the taxonomy of hermit crabs (GB-1304 and GB-4888) with special reference to tropical Atlantic forms with a specific goal of attempting to complete our knowledge of this fauna; to continue studies on the larval development of pagurid anomura based on laboratory rearings in order to utilize ontogenetic information in evaluating phylogenetic relationships within the group; to continue studies on the larval development of other decapod crustaceans of particular importance in systematics with a view towards being able to utilize information on larvae to advance understanding of the systematics of decapod crustaceans; and to summarize the accumulated data on decapod life histories to make possible familial, generic, and for some groups, specific identifications for the West Indian faunal region.

SUPPORTED BY U.S. National Science Foundation

5.0409, LARVAL DEVELOPMENT OF SCYLLARIDEAN LOBSTERS

A.J. PROVENZANO, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

The aims of this project include: identification and detailed description of the larvae of Western Atlantic lobsters of the families Scyllaridae and Palinuridae; the establishemnt of specific and generic characters of phyllosoma and early post-larval stages and evaluation of the significance of larval characters as indicators of natural relationships between species; the initiation of studies on the effects of nutritional and physical environmental factors upon growth and development of phyllosoma larvae in the laboratory.

Larvae will be reared from eggs hatched in the laboratory. Live material captured at sea will be returned to the laboratory to provide an opportunity to study pelagic forms hiterto not observed under laboratory conditions.

SUPPORTED BY U.S. National Science Foundation

5.0410, LARVAL DEVELOPMENT OF DECAPOD CRUSTACEA

A.J. PROVENZANO, Univ. of Miami, Institute of Marine Science, *Miami - Coral Gables, Florida* 33124

This is a continuation of a project to study the larval development of a wide variety of tropical marine decapod crustaceans. Most of the effort in the coming year will be devoted to preparing for publication some of the extensive data obtained during the past four years on the development of brachyuran crabs, anomurans, lobsters and some other groups of decapods. A series of manuscripts describing the external morphology of larval stages especially from a comparative point of view and with regard to characters of systematic value will be furnished. Some analysis of data on effects of temperature, salinity and other environmental factors will be made. A cross-indexed bibliography of decapod larvae will be maintained and expanded to facilitate future work and to aid other workers. For a few groups in which there is sufficient information, an attempt will be made to compile illustrated keys for identification of larval forms.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0411, MONOGRAPH OF THE CEPHALOPODS OF THE NORTH ATLANTIC
G.L. VOSS, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

This project is designed to review the cephalopods of the North Atlantic ocean as a whole and not by local areas as heretofore. The study is based upon very large collections of open ocean species supplemented by smaller but important collections in the major museums of both the U. S. and Europe. The approach is revisionary and monographic. Strong emphasis is placed upon the hydrographic features of the ocean and distribution of the organisms in relation to salinity, temperature, light and depth. Types of most of the species are being examined in the hope of clarifying the present difficult nomenclatural problems in this group of animals.

SUPPORTED BY U.S. National Science Foundation

5.0412, SYSTEMATICS AND ZOOGEOGRAPHY OF ANTARCTIC CEPHALOPODS
G.L. VOSS, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

The research proposed by the University of Miami is a continuation of field and laboratory work which has been supported over the past four years under GA-103, GA-253 and GA-709.

The objectives of this proposal are basically unchanged from the earlier ones:- the completion of a monograph on the systematics of Antarctic cephalopods. The research entails collection of Antarctic specimens through participation on Eltanin cruoses and for first hand observation of characteristics and behavior of fresh specimens. In addition to these materials, all cephalopod specimens obtained under the United States Antarctic Research Program are forwarded to the principal investigator through the Smithsonian Oceanographic Sorting Center. The shipboard studies on Eltanin and data analysis at the University are carried out by graduate assistants who apply their experience and knowledge toward graduate research.

The proposal requires Eltanin participation by one graduate assistant on Cruises 32 and 35, with the possibility of further participation in Tasman Sea and Indian Ocean cruises.

SUPPORTED BY U.S. National Science Foundation

5.0413, CYTOTAXONOMY OF SPECIES OF RELATED PELECYPOD MOLLUSKS
R.W. MENZEL, Florida State University, Graduate School, *Tallahassee, Florida* 32306

The taxonomic and genetic relationships of closely related species of pelecypod mollusks will be studies both by morphological comparisons of the shells from museums and field collections with the shells of laboratory-reared hybrids (when possible) and by investigations of chromosomal behavior at meiosis and mitosis in hybrids, F2's and backcrosses. If it is possible to raise the F2's they will be examined for genetic segregation. Particular emphasis will be given to species of the quahog (Mercenaria) and to oysters (Crassostrea).

SUPPORTED BY U.S. National Science Foundation

5.0414, REPRODUCTIVE RELATIONSHIPS AMONG POPULATIONS OF A MARINE WOOD-BORING ISOPOD
R.J. MENZIES, Florida State University, Graduate School, *Tallahassee, Florida* 32306

Most biologists now accept the genetical species concept (Mayr, 1940, et seq.) which defines a species as 'groups of actually or potentially interbreeding natural populations which are reproductively isolated from other such groups.' This concept has not been extensively applied in systematics due to the practical difficulties involved in testing the reproductive relationships of populations. Therefore, almost all species of marine organisms have been distinguished solely on the basis of their morphological distinctness from other groups of populations.

Morphological distinctness, however, has been shown to be inadequate for the recognition of 'genetic' species in many organisms. On one hand, populations in some taxa have been shown to be reproductively isolated from each other although they differ only minutely in their morphology. Some knowledge of the reproductive relationships of populations is necessary for the recognition of 'genetic species' within a taxon.

The immediate objectives of this research are: 1) to evaluate the reproductive relationships among populations of a widely distributed marine species, Limnoria tripunctata Menzies; 2) to provide a relatively complete analysis of the geographic variability of this species; and 3) to establish criteria useful in the determination of species differences. It is hoped that the proposed research will also contribute toward the elucidation of criteria for the recognition of 'genetic' species in marine isopods.

SUPPORTED BY U.S. National Science Foundation

5.0415, THE OSTRACODA OF THE BAY OF NAPLES
H.S. PURI, State Geol. Survey, *Tallahassee, Florida*

G.W. Muller's classic monograph on the Ostracoda of the Gulf of Naples is also one of the basic works on the ecology of Ostracoda and has been extensively used by later workers. During the spring and summer months of 1961, 1962, and 1963 the principal investigator occupied Muller's Stations. The Zoological Station Naples obtained on loan Muller's syntype material deposited in the Zoological Museum of Greifswald, East Germany, for examination in Naples. Some Syntype material of Muller is deposited in Humboldt University, Berlin, and this material is also being utilized in preparation of a revised monograph on the sediments, ecology, and microfauna of the Bay of Naples. It is hoped that the monograph will include not only a revision of Muller's ostracods but also a study on the hydrography, sediments and ecology of the Bay of Naples based both on foraminfers and ostracods. It has been found that nomenclature and taxonomy of ostracods as described by Muller has undergone drastic changes and also that before species could be used in ecology they needed to be stabilized. It became increasingly obvious that both carapace morphology and soft parts are essential to a natural classification

environments were established and these environments have characteristic faunas. It is proposed to study these eight environments rather thoroughly and studies of the life cycles and morphology will produce a comprehensive and useful work.

SUPPORTED BY U.S. National Science Foundation

5.0416, ESTIMATE OF STANDING CROP OF OYSTERS AND SURVEY OF OYSTER PREDATORS IN GEORGIA
T. LINTON, Univ. of Georgia, Graduate School, *Athens, Georgia* 30602

Objectives: 1. To initiate an inventory and standing crop estimate of oysters on the Georgia coast. 2. To survey the oyster predators, diseases, and competitors present in Georgia waters.

Procedures: A combined technique of statistical sampling and aerial photography will be utilized in estimating the standing crop of Georgia oysters.

Established field and laboratory procedures will be utilized in surveying oyster predators, diseases and competitors present in Georgia waters.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Georgia State Government

5. LIVING SYSTEMS (NON-HUMAN)

5.0417, INVESTIGATIONS OF THE INDUCING CAPACITY OF THE POLAR LOBE IN THE DEVELOPMENT OF THE MARINE GASTROPOD ILYANASSA OBSOLETA

J.W. ATKINSON, Emory University, Graduate School, *Atlanta, Georgia* 30322

No Summary has been provided for use of Science Information Exchange.

SUPPORTED BY Society of The Sigma Xi

5.0418, ECOLOGICAL AND EVOLUTIONARY IMPLICATIONS OF THE ECOTYPES OF ESTUARINE CRUSTACEA

W.D. BURBANCK, Emory University, Graduate School, *Atlanta, Georgia* 30322

Estuaries are of unusual interest to ecologist because they represent tension zones between marine and freshwater environments. Organisms from adjoining communities may be found there along with the biota normally restricted to such zones. The burrowing isopod, Cyathura polita, a typical and very tolerant inhabitant of the Atlantic and Gulf Coast estuaries has been the subject of study by Dr. Burbanck for many years (under grants NSF- G-7138 and G-21145). This organism is a key animal in food chains of tidal marshes and estuaries, and represents a large reservoir of potential energy in many of the estuarine ecosystems; however, our knowledge of Cyathura ecology and distribution and its role in the estuarine ecosystem still remains relatively incomplete.

The proposed work will pursue several lines of ecological investigation in an effort to distinguish ecotypes, to establish definitive characteristics of the taxa within the genus Cyathura, and to prove or disprove the theory of continuing evolution within the genus. Cyathurans from geographically separated populations will be tested for their tolerances and abilities to regulate their metabolism under conditions of external stress. Morphological variations will be noted, and chromatographic analysis is to be employed for delineation of ecotypes. Searches are to be made along the Atlantic Coast for new marine species of Cyathura and new locations of the recently discovered C. burbanki. Finally, museum specimens of Cyathura and animals associated with them are to be examined in order to develop an understanding of the degree to which the biocoenosis varies within the geographical range of Cyathura and how this may influence the occurrence of ecological races.

SUPPORTED BY U.S. National Science Foundation

5.0419, SEASONAL ABUNDANCE AND BIOLOGICAL STABILITY OF THE COMMERCIAL SHRIMP OF GEORGIA

C.M. FRISBIE, State Game & Fish Commission, *Atlanta, Georgia*

Objectives: 1) To determine seasonal and relative abundance of adult and postlarval shrimp opulations. 2) To secure general life history data such as size distribution, maturity, sex ratios, apparent growth, etc. 3) To collect ecological data throughout the shrimp's habitat. 4) To determine relative abundance of competing vertebrates and intertebrates.

Procedures: Adult and juvenile shrimp will be sampled by trawls and cast nets from 21 sampling areas, covering a wide range of habitats. Relative and seasonal abundance of these populations will be determined as well as other aspects of their life history such as sex ratios, stages of sexual maturity, size ranges, and species composition.

Post larval abundance will be monitored with plankton net sampling in order to evaluate spawning success. Environmental parameters will be studied in relation to shrimp populations, to include salinity, temperature, and presence of competitors.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Georgia State Government

5.0420, SURVEY OF A POTENTIAL HARD CLAM FISHERY

W.F. GODWIN, State Game & Fish Commission, *Atlanta, Georgia*

Objectives: 1. To determine the distribution and density of hard clams in Georgia waters. 2. To test several existing techniques for hard clam harvesting, such as small towed dredges, hydraulic rakes, and others 3. To publicize the results of the project to include distribution data, harvesting techniques, expected harvesting cost, and returns.

Procedures: Estuarine areas of Georgia will be surveyed, primarily with a towed dredge, to determine the extent and distribution of hard clam beds. Clam density data and habitat requirements will be determined, as well as estimates of potential reproduction.

Various harvesting techniques will be reviewed and their applicability to the area will be determined. If a commercially feasible clam fishery exists, outfitting and harvesting costs will be developed and be made available to interested parties.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Georgia State Government

5.0421, CONTRIBUTIONS TO THE BIOLOGY OF THE ROYAL RED SHRIMP, HYMENOPENAEUS ROBUSTUS

W.W. ANDERSON, U.S. Dept. of Interior, Biological Laboratory, *Brunswick, Georgia*

Over the past ten years data on size frequencies by sex, stage of sexual development, and relative abundance of the royal red shrimp, Hymenopenaeus robustus, have been collected as opportunity occurred during cruises of the Bureau's exploratory vessels off the coast of the South Atlantic states. These data will be the basis of the first paper dealing with the biology of this deep-water, potentially important commercial species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0422, MANAGEMENT INVESTIGATIONS OF TWO SPECIES OF SPINY LOBSTERS PANULIRUS JAPONICUS AND P. PENICILLATUS

D.E. MORRIS, State Dept. of Land. Nat. Res. , *Honolulu, Hawaii* 96813

The objective of this project is to compile biological information on two species of spiny lobsters, Panulirus japonicus and P. penicillatus, for the eventual scientific management of this resource.

Commercial catch statistics that have been accumulated for almost two decades will be analyzed for trends in fishing effort, catch per unit effort, catch by fishing area, and seasonal abundance.

Biological data collected during a tagging and sampling program, conducted from 1960 to 1962, will be analyzed for information pertaining to growth, movement, population estimates, reproductive habits, and length-weight relationships. Additional biological data needed to complete the study will be acquired through a tagging and sampling program.

Juvenile lobsters will be reared in tanks at the Keehi Fishery Station, Honolulu, in order to compile data on growth and molting and to test methods of tagging or marking small lobsters in the field.

Experimental trapping and tagging of deep water stocks of lobsters will be attempted for purposes of evaluating the composition and extent of these stocks. The successful development of suitable gear for sampling deep water lobster stocks may result in the expansion of the commercial lobster fishery into areas that are not presently fished.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Hawaii State Government

5.0423, CONTINUED STUDIES ON THE INFLUENCE OF THE EGG CORTEX ON THE DEVELOPMENT OF THE MOLLUSCAN EMBRYO

J.M. ARNOLD, Univ. of Hawaii, Pacific Biomedical Res. Center, *Honolulu, Hawaii* 96822

Brief Description of Research Project: The role of the egg cortex in development and differentiation of the mollusc egg has been recently reemphasized. It appears that this layer, which is made up of a plasma membrane and a very thin layer of cytoplasm which lies directly over the yolk platelets, plays an important role in dictating the eventual fate of the cells which come to contain this cortex. Exactly how and where this 'developmental information' is located and how it is transcribed is unknown. The molluscs, Lymnea stagnalis and Loligo pealii, are particularly well suited for such a study, in part because of their well-known mosaic nature and also because of the background information available on them. By using ultraviolet microbeam irradiation, centrifugation and antimitotic agents, it has been possible to demonstrate the egg cortex has definite locations which appear to be causally related to the eventual appearance of specific organs in the cephalopod embryo. Further mapping is being carried out.

SUPPORTED BY U.S. National Science Foundation

5.0424, CEPHALOPOD LENS DEVELOPMENT

J.M. ARNOLD, Univ. of Hawaii, Pacific Biomedical Res. Center, *Honolulu*, *Hawaii* 96822

This investigation is concerned with the development of the cephalopod lens. The lens develops by fusion of many cytoplasmic processes which grow out into the optic vesicle from a group of specialized cells (lentigenic cells). The definitive lens material is elaborated in the lens primordium by fusion of Golgi derived vesicles. Apparently microtubules are in some way involved in the transport and outgrowth of the lentigenic processes. Currently a study is being made of the mechanism of outgrowth of the lentigenic processes, the chemical nature of the adult lens, the steps in synthesis of the lens substance and the causes of aggregation of the cellular processes.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0425, THE ALPHEID SHRIMP OF AUSTRALIA

A.H. BANNER, Univ. of Hawaii, Hawaii Inst. of Marine Biology, *Honolulu*, *Hawaii* 96822

It is proposed to supplement the information and collections now available on the alpheid shrimp of Australia with the view towards monographing the family for Australian waters, as part of our zoogeographic studies in the Indo-Pacific. Presently available, and studied, are collections from various Australian museums; the investigators will study Australian collections and type specimens of Indo-Pacific species in European museums, and then make as many extensive collections as is possible in Australia for subsequent study at the University of Hawaii.

SUPPORTED BY U.S. National Science Foundation

5.0426, NEUROENDOCRINE REGULATION

F.I. KAMEMOTO, Univ. of Hawaii, Graduate School, *Honolulu*, *Hawaii* 96822

Dr. Kamemoto proposes to investigate the neuroendocrine regulation of salt and water balance in crustaceans. Studies have indicated that salt balance in crustaceans is under the influence of a factor or factors from the central nervous system. The secretory site, the role(s) of the secretions, the sites of regulation and the nature of the secretions will be investigated.

SUPPORTED BY U.S. National Science Foundation

5.0427, NEUROENDOCRINE PATHWAYS IN OSMOREGULATION IN CRUSTACEANS

F.I. KAMEMOTO, Univ. of Hawaii, Graduate School, *Honolulu*, *Hawaii* 96822

Dr. Kamemoto plans to spend a year in Japan working with Seiitiro Utida, Ocean Research Institute, University of Tokyo, and Takaaki Ishibashi, Biological Laboratory, Fukuoka University. Studies will be undertaken on the euryhaline shrimp Paneus and the freshwater crab Potamon to elucidate the problem of the differences in neuroendocrine pathways involved in osmoregulation in various crustaceans, depending upon the natural environment in which the animals are found. These studies will be compared with current studies on the freshwater crayfish Procambarus and the estuarine grapsid crab Metopograpsus.

SUPPORTED BY U.S. National Science Foundation

5.0428, PHYSIOLOGICAL MECHANISMS UNDERLYING THE BEHAVIOR OF MARINE CRUSTACEA

E.S. REESE, Univ. of Hawaii, Graduate School, *Honolulu*, *Hawaii* 96822

The behavior patterns of marine crustacea are studied in the field and in the laboratory. The general stimulus situations, the releasing stimuli, the time and sequence relationships of the movements constituting the behavior, and the resultant effects on the behaving organism and other organisms, when the behavior is in a social context, are measured utilizing direct observations, motion picture analysis, models and other experimental devices. A multiple channel event recorder operated by the investigator provides a record of the behavior in terms of frequency, sequence, and coincidence of occurrence. Analysis of these records permits the formulation of a quantitative statement of the behavior which can be treated with standard statistical methods.

Then by rearing the animals in the laboratory under various conditions of isolation and deprivation, the development of the behavior patterns is measured in terms of the same parameters and by the same means as indicated above. By comparing the quantitative expressions of the behavior of inexperienced young animals with those of wild experiemced animals, it is possible to evaluate the role of early experience in the development of behavior.

To date the studies have dealt mainly with the shell selection behavior of hermit crabs, and it has been possible to demonstrate that the shell preferences of the adult animals are not dependent upon their having had past experience with the stimulus objects. Inexperienced, young animals are able to discriminate shells upon their first encounter with them. These studies are continuing with respect to aggressive behavior. In addition, studies on shrimps, particularly with respect to the specialized functions of the appendages, are beginning to develop very nicely. Some preliminary studies have been started on brachyuran coral commensals.

SUPPORTED BY U.S. National Science Foundation

5.0429, POPULATION GENETICS AND LARVAL ECOLOGY OF HAWAIIAN LITTORINA

J.W. STRUHSAKER, Univ. of Hawaii, Hawaii Inst. of Marine Biology, *Honolulu*, *Hawaii* 96822

The shell sculpture polymorphism in the perwinkle, Littorina picta Philippi, and variation in color and color pattern of L. picta and Littorina scabra (Linnaeus) from the Hawaiian Islands will be primarily studied. The research will be designed to study this polymorphism and to ascertain the relative influence of genotypic and environmental factors. Variation in the other Hawaiian species will also be examined in this manner. In approaching these problems, cytogenetic studies and breeding experiments will be combined with rearing and acclimation experiments under different environmental regimes.

The techniques developed for breeding, larval rearing and maintenance of Littorina in the laboratory should be of value to the development of marine larval ecology studies. The development of Littorina species as potential subjects for genetic experimentation could be of greatest importance to the field of marine genetics.

SUPPORTED BY U.S. National Science Foundation

5.0430, VISUAL AND ACOUSTICAL COMMUNICATION IN CERTAIN MARINE CRUSTACEANS

M. SALMON, Univ. of Illinois, Graduate School, *Urbana*, *Illinois*

This grant is for the continuation of studies conducted under GS 3430 at De Paul University.

The purpose of this study is to investigate the role of waving display and sound production as communicative signals in North Atlantic species of fiddler crabs. More specifically, the movements involved in waving display and sound production by males will be filmed and described under a variety of conditions found in the field. Waving display and sound production in populations found in Florida will be compared to that in populations in North Carolina and New York to determine if latitudinal variation in the signal systems exists. The stimuli critical in the elicitation of waving display and sound production will be determined from field observations and via experimental procedures. Sound playbacks, introduction experiments, and other tests will be carried out with males and females at various times of the day and night and the response of the test crabs quantified. These tests will be designed to determine how the crabs respond to signals used in communication and to one another.

SUPPORTED BY U.S. National Science Foundation

5.0431, OIL CONTAMINATION OF OYSTERS FROM OIL WELL DRILLING MUDS

A.F. NOVAK, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge*, *Louisiana* 70803

Objectives: 1. To determine the amount of diesel oil present in contaminated oysters. 2. To determine the threshold amount of oil which can be detected by taste or organoleptically. 3. In what areas or organs of oysters the oil is concentrated. 4. The relationship between concentration of drilling mud in sea water to the oil concentration in the oysters.

At times drilling mud has been released into the surrounding areas. If oyster beds are in the vicinity where drilling muds are released such material can slowly settle over the oyster beds. This may cause the oysters to have an oily taste or if the concentration is high enough death of the oysters.

Oysters will be placed in tanks containing bottom mud mixed with oil drilling mud containing tagged hexadecane C14. Samples of oysters will be removed at regular intervals and the amount of oil from the drilling will be removed at regular intervals and the amount of oil from the drilling mud will be determined by liquid scintillation spectrometry. This is a cooperative project with the La. Wild Life and Fisheries Commission. The Grand Terre Laboratory will conduct the biological work. The extraction of the oil will be conducted in this Department. The spectrometry will be carried out in the Nuclear Science Center at La. State University.

SUPPORTED BY Louisiana State Government

5.0432, CULTURE OF RED SWAMP CRAWFISH, PROCAMBARUS CLARKI, IN BRACKISH WATER PONDS

W.G. PERRY, Rockefeller Wildlife Refuge, *Grand Chenier*, *Louisiana* 70643

The freshwater crawfish is a highly valued food source. Crawfish farms are springing up everywhere. However, persons in brackish water areas of our coastal states are a bit hesitant in investing money into such a venture not knowing if they will receive a profit.

It is the purpose of this project to evaluate crawfish production in saline waters and to determine the maximum salinities in which the crawfish may be cultured.

SUPPORTED BY Louisiana State Government

5.0433, ECOLOGICAL STUDIES OF THE BLUE CRAB, CALLINECTES SAPIDUS

W.G. PERRY, Rockefeller Wildlife Refuge, *Grand Chenier*, *Louisiana* 70643

This project is designed that we may better understand the life history of the blue crab in the estuaries of Southwest Louisiana.

SUPPORTED BY Louisiana State Government

5.0434, LAKE BORGNO - CHANDELEUR SOUND SYSTEM

J.G. BROOM, State Wildlife & Fish Comm., *New Orleans*, *Louisiana*

Objectives: Develop, coordinate, and increase the knowledge about the Gulf shirmp fishery by: (1) postlarval shrimp sampling, (2) juvenile sampling, (3) sampling of over-wintering populations, (4) collection of hydrographic information and (5) processing of data.

Procedures and Work Schedule: (1) Weekly postlarval shrimp sampling in the major passes with 6-foot beam plankton net. (2) Weekly juvenile shrimp sampling throughout the major nursery areas with 6 foot 1/4 in mesh trawls on a seasonal basis. (3) Periodic sampling of over-wintering stocks of shrimp in the coastal marshes and near offshore Gulf waters with shrimp trawls. (4) Collection of hydrographic information including salinity, temperature and tidal data by use of continuous recording meters and portable units. (5) The processing, tabulating and summarizing of collections and raw data, which are to be transmitted to the project leader at the marine laboratory for compilation, analysis and interpretation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Louisiana State Government

5.0435, SHRIMP PRODUCTION IN LOUISIANA SALT-MARSH IMPOUNDMENTS UNDER EXISTING AND MANAGED CONDITIONS

A.H. HARRIS, Francis T. Nicholls State Coll, Graduate School, *Thibodaux*, *Louisiana* 70301

This project is to determine the feasibility of shrimp farming in the impounded marshes and lagoons of Louisiana. The existing productivity of impounded nursery areas already producing shrimp is to be determined and then compared with another area operated under experimental conditions. Natural nursery areas will be encompassed with levees, and water control structures will be used to provide control over movement of tides and shrimp into and out of the impoundments. Both impoundments will be stocked by natural recruitment of the brown (Penaeus aztecus and white (P. setiferus) young shrimp from flood tides.

The second phase of the program is to develop methods of management and harvesting that will determine the economic feasibility of shrimp farming in the Louisiana march. To do this, patterns of ingression and egression, population fluctuations, growth rates, natural mortality, and food habits of both species will be investigated. The effects of predators and parasites also will be determined. The Louisiana Land the Exploration Company, a private owner of extensive marshland acreage, is providing free of charge, the use of some of their land for this research and some of the financial support for the project.

SUPPORTED BY U.S. National Science Foundation

5.0436, LOBSTER RESEARCH

B.E. SKUD, U.S. Dept. of Interior, Biological Laboratory, *Boothbay Harbor*, *Maine* 04538

Two objectives: learn whether there are any biological connections between the inshore and offshore fisheries; determine the essential population characteristics and the environmental requirements for maintaining a maximum catch.

Approaches: 1) Obtain catch records. State of Maine has extensive present and past data on the inshore fishery, so our effort is concentrated on the offshore fishery which takes place along the edge of the continental slope. 2) Study lobster movements. Test a tag which will persist through several moults. Use to determine local, seasonal, and long-distance movements. 3) Develop means of distinguishing discrete groups of lobsters. Utilize studies of morphology, growth, blood-types, and parasites for this purpose. 4) Obtain first-hand and specific knowledge of lobster habitat and behavior through use of SCUBA divers. 5) Study lobster life history. Include studies of fecundity, larval and juvenile stages, growth, and mortality. Investigate relationships of various developmental states to harvestable population. 6) Determine environmental requirements of lobsters, including optimum levels and extremes of tolerance. 7) Utilize output of all studies to make abundance or availability predictions and to establish safe maximum levels of harvesting.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0437, TEMPERATURE AND SALINITY TOLERANCE OF THE SAND SHRIMP, CRANGON SEPTEMSPINSOA

P.A. HAEFNER, Univ. of Maine, Graduate School, *Orono*, *Maine* 04473

This is a continuation of GB-5228. All organisms are subject to a complex of environmental variables. Their response is to the net effect of all stresses applied. The investigator is studying the

interaction of temperature and salinity stresses on non-genetic adaptation of an estuarine animal that normally encounters a wide variation in these factors. Laboratory studies have shown the limits imposed by various temperature-salinity interactions. Field studies now in progress will relate the laboratory findings to survival and distribution of the shrimp in nature.

SUPPORTED BY U.S. National Science Foundation

5.0438, EXCITATION-CONTRACTION COUPLING IN MUSCLE

H. GAINER, Univ. of Maryland, Graduate School, *College Park, Maryland*

This investigation will attempt to further analyse the mechanism whereby the excitation process in the surface plasma membrane of muscle fibers brings about the initiation of contraction even in the deepest myofibrillas layers. The hypothesis that a transverse tubular network with specific membrane properties is the site of the coupling mechanism, will be tested in several crustacean muscle fibers by various electrophysiological and physiochemical experiments. The crustacean species presently under study are the lobster (Homarus americanus) and the blue crab (Callinectes sapidus). Several other species of crab will also be studied with regard to their excitation-contraction coupling processes. It is hoped, that through a comparative approach to excitation-contraction coupling, further insights into the general problems of this process will be provided.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0439, A NON-DESTRUCTIVE METHOD FOR ESTIMATING POPULATION DENSITY AND DISTANCE TO NEAREST NEIGHBOR FOR ESTUARINE MOLLUSCS

A.J. MCERLEAN, Univ. of Maryland, Natural Resources Institute, *College Park, Maryland*

00NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

5.0440, PARASITOLOGY

J.A. COUCH, U.S. Dept. of Interior, Biological Laboratory, *Oxford, Maryland*

Systematic, epizootiological, and zoogeographical studies of significant parasites and commensals of commercial shellfish and associated species are being carried out. Several life history stages of parasites (Minichinia nelsoni and M. costalis) of oysters have been found and identified. A three-year study of the epizootics caused by both of these parasites has been completed for Chincoteague Bay, Virginia.

Oysters from estuarine waters of the Middle Atlantic and Southern States are being examined for M. nelsoni (MSX) and M. costalis (SSO) and other potentially pathogenic organisms. This study has given us an incomplete but valuable conception of the possible presence or absence of these parasites in significant oyster producing areas on the eastern coast. Thus far it has been learned that the range of M. nelsoni extends at least as far north as New Haven, Connecticut, and as far south as the New River, North Carolina. 036

Blue crabs are being examined from several areas in Chesapeake Bay and waters of the southeast United States where heavy mortalities have been reported. Parasites were identified and one gill commensal, Lagenophrys (a peritrichous ciliate), has been described and is being studied as a contributor to the mortalities. Further studies are planned on the 'Grey Crab disease' believed to be caused by an ameboid organism.

The long-range goal of the project is to better understand the roles that parasites and commensals play as limiting factors in the abundance and utilization of shellfish.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0441, PATHOLOGY - EPIZOOTIOLOGY

C.A. FARLEY, U.S. Dept. of Interior, Biological Laboratory, *Oxford, Maryland*

The pathological, parasitological, epizootiological, and cytochemical relationships of diseases in oysters are being studied. Receiving greatest attention with regard to the above is the haplosporidan, Minchinia nelsoni, an oyster parasite associated with massive oyster mortalities in Delaware and Chesapeake Bays. With the repeated discovery of definitive life cycle stages, its life history within the oyster has now been proposed. A system for determining stages of infection has been developed and is being utilized for interpretation of epizootiological data. Comparative studies are being made of epizootiological patterns in four populations of oysters in Pocomoke Sound, Maryland. Methods are being developed for determining DNA-RNA patterns in hosts and parasites and is receiving intensive study. Studies are also being made of causes of mortality in oysters from the west coast of the United States, British Columbia, and France and are being compared with local mortality causes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0442, PACIFIC OYSTER MORTALITY STUDIES

A. ROSENFIELD, U.S. Dept. of Interior, Biological Laboratory, *Oxford, Maryland*

Efforts are being made to identify or discover those factors, particularly disease agents, responsible for shellfish mortalities on the west coast of the United States and Canada. Epizootiologic and pathologic studies are being conducted to determine timing, patterns, and possible causes of mortalities, and to determine pathogenicity of disease agents. Shellfish from exotic and domestic 'seed' supply areas are screened for micropathogens or disease organisms before introduction or importation of these shellfish into west coast grwoing areas.

Shellfish from several Far East potential 'seed' sources have been and are being examined microscopically for the presence of microparasites, micropathogens, and disease conditions. Many previously unobserved or unreported microparasites and disease conditions have been seen in these specimens. Reports and appropriate recommendations are sent to pertinent Pacific Coast state agencies, and when deemed necessary, recommendations for quarantines or embargoes on shipments are given.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0443, PROTOZOOLOGY

T.K. SAWYER, U.S. Dept. of Interior, Biological Laboratory, *Oxford, Maryland*

Methods and procedures are being developed to establish protozoan parasites from oysters and other shellfish in xenic and axenic culture. Techniques such as enzyme dissociation, gradient centrifugation, and selective filtration for the isolation of protozoans from oyster tissue and the environment are being investigated. Isolates are grown on special nutrient media in the presence of various food sources to determine survival periods and 'growth' potential of the organisms. Nuclear division and morphology of trophic forms are being studied by phase contrase, and with the use of differential strains. Taxonomic studies are in progress using fluorescent antibody techniques.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0444, CULTURE OF SHELLFISH IN ARTIFICIAL AND NATURAL SALT PONDS

W.N. SHAW, U.S. Dept. of Interior, Biological Laboratory, *Oxford, Maryland*

Early in 1964, four one-quarter acre artifical ponds were completed near the laboratory at Oxford, Maryland. Studies are being conducted on the growth and survival of oysters in these ponds. Studies are being conducted in one of the ponds for catching oyster set and fattening oysters. Attempts to fertilize the ponds to increase productivity are underway.

Studies are planned on the growth and survival of oysters suspended from a rigid structure on the Tred Avon River adjacent to the laboratory. Preliminary studies indicate that the river is favorable for good oyster growth. Strings of oysters will be suspended and their growth and survival studied.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5. LIVING SYSTEMS (NON-HUMAN)

5.0445, POTENTIAL OYSTER SETTING CAPACITY - LOCAL AREAS

W.N. SHAW, **U.S. Dept. of Interior, Biological Laboratory, *Oxford, Maryland***

This project is concerned with the setting capacity of oysters in local waters, principally the Tred Avon River, Broad Creek, and Harris Creek, on the Eastern Shore of Chesapeake Bay in Maryland. Yearly, stations are established in each area, and during the oyster setting season (June to October) collectors in the form of oyster shells and asbestos flexboards are put out at each station. Total amount of setting and period of setting intensity are measured by counting daily and weekly the number of oyster spat on these collectors. In addition, the amount of fouling competitors for space is studied.

Studies on the rafting of shells to catch seed oysters are being conducted. Rafts are being placed in areas where setting intensity has been high. Shells on strings and in bags are being suspended from the rafts during the setting season. Once the seed is caught they are removed from the rafts and suspended from a rigid structure to grow to market size. The long line method to catch and grow seed oysters is to be tested in several areas.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0446, ECOLOGY AND DISTRIBUTION OF OYSTERS AND CLAMS

W.N. SHAW, **U.S. Dept. of Interior, Biological Laboratory, *Oxford, Maryland***

The natural populations of commercial shellfish in local areas have been delimited. Zooplankton and phytoplankton levels in shellfish producing areas are being determined and the organisms involved are being identified. The effects of physical and chemical factors on plankton, and on larval, juvenile, and adult stages of commercial shellfish are being determined. Qualitative and quantitative observations are being made on the invertebrate animals in local areas, and numbers and living habits related to effects on commercial species. Food webs, within the small estuarine tributaries of Chesapeake Bay, are being established. Ecological studies in large man-made salt water ponds have been undertaken, and all information, from natural and artificial situations, will be related to maintenance of shellfish in these ponds.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0447, GROWTH, CONDITION, AND SURVIVAL OF SHELLFISH

W.N. SHAW, **U.S. Dept. of Interior, Biological Laboratory, *Oxford, Maryland***

In recent years the oyster industry in Chincoteague Bay has been importing oysters from other regions into the bay to hold for future marketing. At present, studies are being conducted to see if these oysters adapt to this new environment. Oysters from low salinity waters are suspended in trays in Chincoteague Bay. Their growth, condition, and survival are monitored.

Monthly, a comparative analysis is made on the conditions, percentage of solids, of oysters on two natural bars--one in broad Creek and one in the Tred Avon River. At each locality the effects of crowding and fouling are being studied.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0448, SURF CLAM POPULATION DYNAMICS

R.M. YANCEY, **U.S. Dept. of Interior, Biological Laboratory, *Oxford, Maryland***

The commercial hydraulic jet dredge has been modified to sample clams without bias in sizes larger than two inches.

Clam occurrence on the Atlantic coastal shelf between the Hudson Canyon and Cape Charles will be determined. Clam abundance in time and place will be described according to commonly understood measures.

The normal yearly recruitment of juvenile clams to the major populations will be determined. Variations in year class abundance will be estimated, with special attention to probable dominant year classes. The rate of clam survival before the size and age when they are harvested commercially (about four inches long) will be determined. The rate at which clams usually become available to the commercial fishery as a function of their size (or age) will be estimated. Such availability will be related to mortality, including fishery removals. The effects of fishing upon population composition, natural survival, and natural recruitment will be determined. The rate of repopulation of depleted grounds will be estimated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0449, SURF CLAM BIOLOGY

R.M. YANCEY, **U.S. Dept. of Interior, Biological Laboratory, *Oxford, Maryland***

As a part of the life history project, samples of surf clam, Spisula solidissima, gonads are routinely collected from New Jersey ports of landing and from other areas along the Atlantic Coast. The gonads are prepared for microscopic examinations of gametogenesis to determine the frequency, duration, and times of spawning. Since the gonad samples are taken from large mature clams, other gonads will be collected from smaller clams to determine sexual maturity. These observations will provide basic knowledge useful in studies of recruitment, repopulation, and the extent of the spawning population of this commercial shellfish.

Studies are being conducted to develop reliable aging techniques and to determine the growth rate of surf clams, since little is known about the length of time it takes for these clams to reach a marketable size. Frequency distributions of shell length measurements will be collected from samples taken at sea, port landings, and beaches. The feasibility of marking and tagging clams is being explored to provide direct evidence of clam age and growth.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0450, FREEZING AND DRYING OF LIVING CELLS

H. MERYMAN, **U.S. Navy, Medical Research Inst., *Washington - Bethesda, Maryland***

Objective: a. Problem: To investigate the mechanisms whereby freezing and drying affects living cells. b. Application: Determination of methods of protection of cells under severe environmental conditions. c. Injury to cells subjected to freezing can be either mechanical (ice crystal edges cutting into cell components) or chemical (chemical reactions and/or concentrations of chemicals due to dehydration).

Approach: The work will include pertinent studies and completion of studies on the freezing resistance of nematodes. Further studies will begin on freezing resistance and sensitivity on intertidal mollusks. Other work will be conducted on thermal analysis as a means for observing the development of phase changes during temperature cycling. Work will also continue on the effect on survival of storage of evaluated temperature under varying equilibrium water vapor pressures and subjected to gamma radiation. Additional work will be performed to investigate reported degradation of biological materials in liquid nitrogen.

Progress: A close correlation has been found between the onset of injury in freezing and the proportion of water frozen for several biological materials with widely divergent temperatures of injury.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

5.0451, PARASITIC COPEPODA %CRUSTACEA*ROM INVERTEBRATES AND FISHES*

A.G. HUMES, **Boston University, Graduate School, *Boston, Massachusetts* 02215**

Large collections of copepods, all parasites or associates of marine fishes or invertebrates, will be studied with emphasis upon morphology and systematics. These copepods come from mainly the West Indies and Madagascar, those from the latter area having been collected during the International Indian Ocean Expedition in 1963-64.

SUPPORTED BY U.S. National Science Foundation

5.0452, COASTAL LOBSTER FISHERY

A.E. PETERSON, State Dept. of Nat. Resources, *Boston, Massachusetts*

Objective: To obtain accurate lobster landing statistics, including location, catch, effort, and gear from the licensed Massachusetts lobster fisherman.

Procedure: All licensed lobster fishermen are required to submit annual reports before new licenses are issued. The license holders will be divided into commercial and non-commercial categories. The commercial lobster fishermen will then be required to submit monthly catch reports. The validity of these reports will be checked by interviewing a random sample of the license holders. This information will then be compared and correlated with individual, annual, and/or monthly reports. An attempt will be made to improve catch reports, and it is anticipated that it will be possible to utilize weigh-out slips when the fisherman sells his lobsters to the dealer. With both parties retaining a copy of this slip, further verification of reports can be made through comparison.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Massachusetts State Government

5.0453, OFFSHORE LOBSTER FISHERY

A.E. PETERSON, State Div. of Marine Fisheries, *Boston, Massachusetts*

Objective: To obtain accurate lobster landing statistics, including location, catch, and effort, from the otter trawl draggers catching lobsters.

Procedure: A survey of the Massachusetts ports where draggers land their catches will be made to ascertain the extent of lobster landings at each port. It is proposed that weigh-out slips will then be utilized as a source of catch statistics. Both the fishermen and the dealer would be required to submit monthly reports. Interview sampling will be used to verify the reports.

Time: This phase will not be initiated during the first year of operation, since the Bureau of Commercial Fisheries, Boothbay Laboratory, is currently engaged in a similar project under their offshore lobster investigations.

It is planned to perform this phase in subsequent sub projects.

Part 2 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Massachusetts State Government

5.0454, BIOLOGY OF THE ANTARCTIC BRACHIOPOD FAUNA

B. KUMMEL, Harvard University, Graduate School, *Cambridge, Massachusetts* 02138

Support is provided to Harvard University for the third and final year for the completion of quantitative and qualitative studies on Antarctic brachiopod taxa. This will complete studies of the soft part anatomy and sections of shell for taxanomic and evolutionary characters, determine skeletal support through x-ray techniques and utilize electron probe for information on elemental variations. The overall objective is to provide a modern biological study of Antarctic brachiopods, essential to an understanding of brachiopods in general, with information on the ecology and zoogeography of Antarctic genera and species. The support will assist in the preparation of a manuscript for publication.

Under GA-430, the investigators have incorporated data on 39 genera and 78 species reported in the literature of the Antarctic Region. These have been projected in a series of charts with appropriate text for publication in the marine biology volume of the Antarctic Map Folio Series. Specimens representing 12 genera and 78 species have been assembled on lean from foreign and domestic museums for study of regional differences. Visits have been made or are planned to New Zealand, Australian and British Museums for examination of type specimens. Material in excess of 10,000 speciemns has been collected through participation in Eltanin cruises 27 and 32. This provided fresh specimens for observation on feeding and reproduction and for histological and systematical information on structure and function.

This data study will be conducted at Harvard University; there are no requirements for field work.

SUPPORTED BY U.S. National Science Foundation

5.0455, HISTOCHEMICAL STUDIES OF MUCOSUBSTANCES IN THE MANTLE OF THE NORTHERN QUAHOG, MERCENARIA MERCENARIA

R.E. HILLMAN, William F. Clapp Laboratories, *Duxbury, Massachusetts* 02323

The objective of this study is to localize and describe mucopolysaccharides and mucoproteins in the mantle edge of the quahog clam, Mercenaria mercenaria. These mucosubstances vary in vary in chemical composition from area to area within the mantle edge. It is reasonable to assume they are performing relatively sophisticated physiological functions because of the variations in structure and the fact that similar mucosubstances in higher forms have specific physiological roles. By localizing and identifying the various mucosubstances in the clam one might be able to correlate the functions of these substances in the clam with those in the higher forms. It might then be possible to learn more about the mechanism of action of these substances. For example, a comparison of the glycosaminoglycans aiding in shell deposition in the clam with similar dermatan sulfate found associated with calcification in higher organisms might provide information as to glycosaminoglycans function in the overall mechanism of calcification.

SUPPORTED BY Battelle Memorial Institute

5.0456, SEA CLAM EXPLORATIONS

P.S. PARKER, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Gloucester, Massachusetts* 01930

Detailed systematic area clam surveys along the North Atlantic coast of the United States are conducted. The purpose of the surveys are to gather information on the abundance, distribution and size of surf clams (Spisula solidissima) and other species found with a potential commercial use and to determine from this information if the surf clam and other species populations located are suitable for commercial exploration. It is anticipated that this information will be used by the surf clam industry to make future management plans for maintaining a healthy growing natural population.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0457, NORTHERN SHRIMP EXPLORATIONS

P.S. PARKER, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Gloucester, Massachusetts* 01930

Seasonal exploratory fishing surveys are being conducted in Gulf of Maine and Georges Bank waters to locate and delineate populations of northern shrimp (Pandalus sp.) that may be available in sufficient quantities to support expansion of the commercial fishery for this species.

Special trawls and shrimp handling equipment are being developed to promote the most efficient harvesting of shrimp and rapid handling aboard ship.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0458, SYSTEMATICS MORPHOLOGY AND ECOLOGY OF THE GENUS ERVILIA (MOLLUSCA: PELECYPODA) IN THE WESTERN ATLANTIC

J.D. DAVIS, Smith College, Graduate School, *Northampton, Massachusetts* 01060

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

5.0459, DEMINERALIZATION-BORING MECHANISMS OF MOLLUSKS

M.R. CARRIKER, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

Continue studies of the degree of penetration of the ABO* secretion into the surface of shell in the bore hole of Urosalpinx during boring by means of microradiography (titanium radiation), and by means of the scanning electron microscope.

Continue studies to elucidate the metabolic pathways in the Urosalpinx ABO which may control the action of carbonic anhydrase activity in decalcification.

Continuous preparation of manuscripts on (a) behavior of shell penetration by Urosalpinx cinerea follyensis, and (b) comparative functional morphology of the ABO of muricid gastropods.

Continue organization of international symposium on the penetration of calcareous substrates by invertebrates and lower plants for the AAAS Meetings in 1968 under major sponsorship of the American Society of Zoologists.

*ABO is the accessory boring organ of the muricid boring snail Urosalpinx cinerea follyensis (Baker).

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0460, THE POPULATION ECOLOGY OF GEMMA GEMMA (PELECYPODA, VENERIDAE), A DOMINANT SPECIES IN BARNSTABLE HARBOR, MASS

R.H. GREEN, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Whitehall Foundation

5.0461, SYSTEMATIC STUDIES OF ANTARCTIC COPEPODS

T.S. PARK, Woods Hole Oceanographic Inst., *Woods Hole, Massachusetts* 02543

The definitive taxonomic treatment of Antarctic calanoid copepods from Eltanin zooplankton will be carried out at Woods Hole Oceanographic Institution. Preliminary sampling of zooplankton and mid-water trawls made on Eltanin Cruise 17 reveals 53 species; these have been analyzed for size variations, species composition and numerical abundance. Continuation of this systematic study, using materials from selected stations made by Eltanin in earlier cruises in the Southern Ocean, will permit a complete faunistic treatment of all samples. In addition, an attempt will be made to determine the biological significance of the Antarctic convergence and the hydrology of the entire Southern Ocean in the habit and distributional pattern of pelagic copepods. The calanoid copepods will be studied in terms of comparative anatomy, biometry, and distribution with the ultimate objective of producing a comprehensive monograph, including illustrated keys to species.

The samples required in this study will be provided through the Smithsonian Oceanographic Sorting Center where the zooplankton hauls and midwater collections are rough sorted and curated. Labelled specimens will be returned by the principal investigator at the conclusion of the work to the SOSC. All type specimens will be deposited at the U. S. National Museum. It is planned tentatively to participate in one Eltanin cruise.

SUPPORTED BY U.S. National Science Foundation

5.0462, CUES INVOLVED IN VERTICAL MOVEMENT AND STATIC ORIENTATION OF GASTROPODS

A. MCCLARY, Michigan State University, Graduate School, *East Lansing, Michigan* 48824

Brief Description of Research Project: The relative importance of several potential cues to vertical movement of Helix pomatia and Pomacea paludosa will be investigated. This will be done by depriving various groups of snails of one or more of these cues and then testing their ability to travel upwards on slopes or vertical surfaces. Statocyst stimulation as a cue will be abolished by removing statocysts as done in previous work. Some snails will also be sham operated to provide a check for the effects of simple operative incision as compared to incision plus statocyst removal. Light as a cue will be abolished by blinding, shell muscle proprioceptors by floats or strings attached to shell apices. In the case of Pomacea, two other potential cues, namely oxygen gradients and lung gas, will also be abolished.

In a similar manner, substrate contact, statocyst stimulation, and light will be investigated as potential cues for static orientation.

SUPPORTED BY U.S. National Science Foundation

5.0463, PHYSIOLOGY OF THE LIMULUS HEART

R.A. PAX, Michigan State University, Graduate School, *East Lansing, Michigan* 48824

The rhythmically active neural tissues of neurogenic hearts present simple systems for study of problems of initiation, maintenance, and regulation of neurogenic rhythms in general. The decapod crustacean heart has been intensively studied in recent years but the basic questions concerning neurogenic rhythms have not yet been answered.

It is proposed here that a neurogenic rhythm in a different class of animals be studied. The neurogenic rhythm proposed for this study is that of the heart of Limulus, the horse-shoe crab. This study, entailing histological, electrophysiological and pharmacological experiments, is expected to answer the questions of whether mechanisms by which neurogenic rhythms arise are the same in different animal groups and whether the Limulus heart is a more favorable preparation for an attack on the problem of how such rhythms are initiated, maintained and regulated.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0464, EFFECTS OF HIGH TEMPERATURE, LOW OXYGEN, AND PH EXTREMES ON THE SURVIVAL OF AQUATIC INSECTS AND CRUSTACEA IMPORTANT AS TROUT FOOD

A.V. NEBEKER, U.S. Dept. of Interior, Natl. Water Quality Lab., *Duluth, Minnesota*

To establish dissolved oxygen, temperature, and pH requirements for various species of aquatic insects and crustacea which have been found to be important in the food chain of brook, rainbow, and lake trout. Two species of Lake Superior crustaceans, Mysis relicta and Ponteporeia affinis, and five species of aquatic insects, Acroneuria lycorias, Taeneopteryx maura, Brachycentrus americanus, Hydropsyche betteni, and Ephemerella subvaria, will be used as test organisms. The work will consist of determining the TLm(LD50) values for 96 hours and 30 days, and longer if possible, for high temperatures, low oxygen, and low and high pH.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0465, A STUDY OF COLIFORM BACTERIA AND ESCHERICHIA COLI ON POLLUTED AND UNPOLLUTED OYSTER BOTTOMS OF MISSISSIPPI

G. GUNTER, State Marine Conserv. Comm., *Biloxi, Mississippi*

Objectives: 1) To establish a regular sampling program on transects across Mississippi Sound and extending from fresh water to the Gulf of Mexico and on selected polluted and unpolluted oyster reefs. 2) To perfect technique for collecting comparable samples. 3) To complete bacterial analyses of collected samples. 4) To compare the bacterial flora from polluted and unpolluted areas of Mississippi Sound and adjacent waters, especially as it relates to sewage polluted oyster beds.

Procedures: 1) Field - (a) Surface, mid-water and bottom samples will be collected at established stations where there is sufficient depth of water. Additional samples will be collected as necessary. (b) Techniques to insure the collection of samples under sterile conditions will be established. (c) Temperature and salinity will be determined at all stations. (d) Collected samples will be refrigerated and returned to the laboratory for analysis. 2) Laboratory - (a) The Most Probable Number of coliform organisms and of Escherichia coli of presumptive human fecal origin will be determined by competent bacteriologists. (b) Additional studies will be carried out where feasible.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Mississippi State Government

5.0466, POPULATION STUDIES OF HAUSTORIIDAE AND GAMMARIDAE FROM NEW ENGLAND AND ON INFAUNAL AND EPIFAUNAL MARINE AMPHIPODS AT ENIWETOK

R.A. CROKER, Univ. of New Hampshire, Graduate School, *Durham, New Hampshire* 03824

I. This research focuses on two families of marine amphipods: 1) Gammaridae, with epifaunal, boreal-subarctic species of wide ecological valence, that presently show different morphological and population characteristics when coastal and estuarine populations are compared, and 2) infaunal Haustoriidae from intertidal and subtidal sands showing more ecological specialization to their respective niches, less morphological variation, and more narrow reproductive periods. Objectives are to elucidate: 1) geographic and infraspecific variation as related to ecological specialization, 2) population structure, including clines, isolates, peripheral populations, fluctuations, intergradations, and dispersal, 3) breeding systems including ecological, reproductive and chromosomal factors, and 4) environmental factors acting on populations.

II. This research concerns studies on marine amphipods of tropical Pacific sand substrata and was designed primarily to provide knowledge concerning zoogeography and life histories of Micronesian species. The research emphasizes collecting in fine calcareous lagoon sediments of Pacific atolls to provide population data on: distribution, density, specific composition, reproductive cycles, fecundity, sex ratio, growth, and food. Particular stress is placed on life history aspects, distributional ecology and infra specific variation.

SUPPORTED BY University of New Hampshire
U.S. Atomic Energy Commission

5.0467, PURIFICATION OF HARD CLAMS FROM POLLUTED WATERS

H.H. HASKIN, Rutgers The State University, Graduate School, *New Brunswick, New Jersey* 08903

This project is designed to define optimal conditions for maximum hard clam activity. The activities of greatest interest are those which purify (depurate) the clams of bacterial and viral contaminants. Since purification experiments are lengthy and involved, other indicators of clam activity will be used in a study of such environmental parameters as temperature, salinity, turbidity, food levels, light, oxygen levels, etc. Uptake and disposal of bacterial and bacteriophage contaminants will be further studied in the laboratory and the results of these studies will be related to bacterial and, hopefully, enteric viral levels in the Raritan Bay estuary and its clam populations.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0468, BIOCHEMICAL CHARACTERIZATION OF CHOLINESTERASES IN THE BLOOD ANDCENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS

R. VONBURG, Montefiore Hosp. & Med. Ctr. , *Bronx, New York* 10467

Acetycholine-cholinesterase systems have been found in all arthropods studied. However, information is lacking on Limulus polyphemus. This organism has the additional interest of being considered a living fossil. Therefore, from a comparative as well as a phylogenetic point of view, an attempt is being made to characterize the pseudo and true cholinesterases in the blood and central nervous system of adult organisms. The technique involves the rate of enzymatic acid production as measured by an autoburette in response to specific substrates. Work is being conducted at Montefiore Hospital and should be completed by 1969.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0469, NEUROPHYSIOLOGICAL INVESTIGATIONS OF LIMULUS CENTRAL NERVOUS SYSTEM

R. VONBURG, Fordham University, Graduate School, *New York, New York* 10458

The circumesophageal collar, haemal nerves and ventral cord were investigated for controlling influences on the heart rate of Limulus polyphemus. Electrical stimulation and surgical lesioning were the principal techniques. Recordings were made by means of an oscilliscope and polygraph.

The forebrain was found to exert a contralateral driving force on the haemal nerves 7 and 8 which are known to control the heart rate. However, contrary to Pax and Sanborn (1964) the output of these nerves was found to be only inhibitory.

The ventral cord was also found to control cardiac rate.

The control resides within the abdominal ganglia and there appears to be a functional hierarchy that begins with the first abdominal ganglion and diminishes with each successive ganglion. Here again, there appears to be a contralateral driving influence on an inhibitory output. Several models of Limulus c.n.s. are possible. In an effort to eliminate some of these possibilities, single fiber analysis of the outputs of the abdominal ganglia will be attempted.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

5.0470, THE EFFECT OF SOME NEUROTRAMSMITTERS ON THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS

R. VONBURG, Fordham University, Graduate School, *New York, New York* 10458

Acetylcholine bromide, gamma-aminobutyric acid, 5 hydroxytryptamine, 3 hydroxytryptamine, histamine, L-glutamine, epinephrine, nor epinephrine and the inhibitors, curare, atropine, reserpine, eserine and picrotoxin were studied.

Application of the drugs was accomplished by cannulating the ventral cord connective tissue sheath with a polyethylene needle. Cardiac rate and nerve firing rate were recorded by an oscilloscope and polygraph.

Acetylcholine bromide and gamma-aminobutyric acid at 0.01 molar concentrations appear to be the only substances tested that were able to produce consistent changes. Acetylcholine increased nerve activity and enhanced the heart rate while the reverse was true with gamma aminobutyric acid. Only eserine and picrotoxin were effective as inhibitors. Other agents are currently being tested.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

5.0471, MECHANISMS OF VENTILATORY CONTROL

M. MENDELSON, New York University, School of Medicine, *New York, New York* 10003

A system of interneurons and motoneurons in the suboesophageal ganglion of the hermit crab is to be studied further. This system, which controls the ventilatory appendage of the crab has been found to operate in essentially normal fashion in vitro for considerable periods. Interaction among the inter- and motorneurons are being analyzed.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0472, PHYSIOLOGICAL VARIATION AND ECOLOGY OF MOLLUSCS

W.D. HUNTER, Syracuse University, Graduate School, *Syracuse, New York* 13210

The proposed work continues and extends the field and laboratory studies on the physiological ecology of molluscs previously carried out by the principal investigator. The major long-term studies involve field investigations of respiratory behaviour, growth, reproductive pattern, and population dynamics in selected natural populations of fresh-water and marine littoral molluscs. There are two main objectives in these studies: (a) to determine the extent and nature of physiological variation between natural populations of the same species, for example, in respiration and in reproduction, and (b) to attempt to produce population 'balance sheets,' that is, assessments of population turnover in relation to total species biomass, including field estimates of metabolic rates and energy flow through the populations concerned. The long-term field work on natural populations is supplemented by cognate experimental studies, mostly short-term, on specific aspects of physiology or ecology in molluscs. Examples include studies on control of diapause and onset of breeding in snails, on respiratory adaptations, on locomotion, on water control, on methods of assessment of population density and dispersal, and on the ecology of closely related species.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5. LIVING SYSTEMS (NON-HUMAN)

5.0473, EFFECT OF ENVIRONMENTAL CHANGES ON BLUE CRAB ABUNDANCE

M.H. JUDY, U.S. Dept. of Interior, Biological Laboratory, *Beaufort, North Carolina* 28516

Under this project the following studies are planned or are in progress in North Carolina waters: (1) relative abundance and distribution of all life history stages. (2) migratory movements of adult blue crabs. (3) species composition of crab population. (4) development of methods to estimate adult crab population size (5) relationship between size of spawning population and resulting marketable size progeny.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0474, ACCUMULATION OF RADIOACTIVITY BY INVERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)

T.J. PRICE, U.S. Dept. of Interior, Radiobiological Lab. , *Beaufort, North Carolina* 28516

The rapid growth of atomic energy industries and the increased use of nuclear reactors for power production have increased the possibility of the contamination of the marine environment with radioactive materials. Also, radioisotopes used in research and medicine may be disposed of in coastal waters, which are habitats for many species of commercial marine invertebrates.

Since many invertebrates are filter-feeders, omniverous predators, and scavengers, it is probable that these animals come in contact with most components of the ecosystem. If one or more of these components contain radionuclides, it is probable that this radioactivity eventually would become associated with these animals.

Laboratory research is being done to determine the uptake, accumulation, and retention of specific radioisotopes (zinc-65, iron- 59, iodine 31 and others) by marine invertebrates, including clams, oysters, scallops, and crabs. From these experiments, one can ascertain the importance of various factors which may affect accumulation; observe the metabolism of specific elements by invertebrates through the use of radioactive tracers; and study the foods and feeding activities of marine invertebrates.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0475, SURVIVAL REQUIREMENTS OF JUVENILE AND ADULT BLUE CRABS

M.E. TAGATZ, U.S. Dept. of Interior, Biological Laboratory, *Beaufort, North Carolina* 28516

The project has three phases, which will be undertaken in the order in which they are listed. Phase 1. Determine the nature of, and the capacity for osmotic and ionic regulation in juvenile and adult blue crabs. Phase 2. Determine factors affecting length of intermolt period and percentage increase in size at time of molt. Phase 3. Analyze responses of juveniles and adults to environmental stresses such as salinity, temperature, pH, dissolved oxygen, etc., under controlled laboratory conditions, to establish parameters within which survival is possible. Within these parameters, determine optimum conditions for growth and reproduction.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0476, CONTROLLED ENVIRONMENTAL FACTORS ON THE DEVELOPMENT OF ESTUARINE AND OCEANIC CRUSTACEA

J.D. COSTLOW, Duke University, Graduate School, *Durham, North Carolina* 27706

The research program has the following objectives: 1. To study, under controlled laboratory conditions, the larval development of crabs which are found in estuaries and oceanic waters in the vicinity of Beaufort, North Carolina. 2. To determine the effect of temperature, salinity, and pressure on larval development. 3. To determine whether daily changes in temperature and salinity affect molting frequency, duration of larval life and survival in the same manner as when these factors are kept constant throughout larval life. 4. To study the larval development of a few crabs which have a broad geographical distribution and determine whether larvae of the same species from different latitudes and longitudes of the geographical range exhibit the same or different tolerances to common environmental factors.

SUPPORTED BY U.S. National Science Foundation

5.0477, RELATIONSHIPS AMONG POPULATIONS OF LIMNORIA TRIPUNCTATA

R.J. MENZIES, Duke University, Graduate School, *Durham, North Carolina* 27706

Most biologists now accept the genetical species concept (Mayr, 1940, et seq.) which defines a species as 'groups of actually or potentially interbreeding natural populations which are reproductively isolated from other such groups.' This concept has not been extensively applied in systematics due to the practical difficulties involved in testing the reproductive relationships of populations. It is especially difficult to evaluate marine species with respect to the interbreeding criterion, particularly those which are widely distributed or which come from the deep sea. Almost all species of marine organisms have been distinguished solely on the basis of their morphological distinctness from other groups of populations. Many marine organisms require stringent laboratory conditions for their cultivation. In most marine species even the culture requirements are not known. This is not the case with Limnoria which is among the easiest marine invertebrates to culture.

Morphological distinctness, however, has been shown to be inadequate for the recognition of 'genetic' species in many organisms. On one hand, populations in some taxa have been shown to be reproductively isolated from each other although they differ only minutely in their morphology. Some knowledge of the reproductive relationships of populations is necessary for the recognition of 'genetic species' within a taxon.

The immediate objectives of this research are: 1) to evaluate the reproductive relationships among populations of a widely distributed marine species, Limnoria tripunctata Menzies; 2) to provide a relatively complete analysis of the geographic variability of this species; and 3) to establish criteria useful in the determination of species differences. It is hoped that the proposed research will also contribute toward the elucidation of criteria for the recognition of 'genetic' species in marine isopods.

SUPPORTED BY U.S. National Science Foundation

5.0478, GAMETOGENESIS AND FERTILIZATION IN THE BLUE CRAB, CALLINECTES SAPIDUS RATHBUN, AND OTHER CRABS

E.P. RYAN, East Carolina University, Graduate School, *Greenville, North Carolina* 27835

The proposed research includes a detailed study of gametogenesis, fertilization and cleavage in the blue crab, Callinectes sapidus. Examination by light and electron microscopy will accompany cytochemical techniques to reveal the modifications of organelles in the maturation of the aflagellate sperm. Of particular importance is the functional morphology of the elaborate acrosomal complex. Development of a technique of artifical insemination will permit an appraisal of changes of the varied organelles and their function in the fertilization process. Comparison will be made of these structures and processes in related Brachyura to reveal basic patterns in sperm morphology and function which indicate phylogenetic relationships within the Decapoda. The research will be conducted at East Carolina College and at the Duke Marine Laboratory.

SUPPORTED BY U.S. National Science Foundation

5.0479, MORPHOLOGY, PHYSIOLOGY AND ECOLOGY OF MARINE LAMELLIBRANCHS

A.F. CHESTNUT, Univ. of North Carolina, Institute of Marine Science, *Morehead City, North Carolina* 28557

Morphology, physiology and ecology of marine lamellibranchs. Studies are in progress of early development, setting behavior and feeding mechanisms.

SUPPORTED BY University of North Carolina

5.0480, COLLECTION AND SURVEY OF NORTH CAROLINA MARINE AND ESTUARINE MOLLUSCA

H.J. PORTER, Univ. of North Carolina, Institute of Marine Science, *Morehead City, North Carolina* 28557

A curated and catalogued collection of North Carolina mollusks is being developed and maintained. Specimens are procured primarily from surveys conducted in North Carolina estuarine and marine waters. Purpose of the long term project is to document occurrence and extent of the North Carolina molluscan fauna, provide a permanent repository for examples of this fauna and provide an available systematic study collection for teaching and/or ecological research.

SUPPORTED BY University of North Carolina

5.0481, CRUSTACEAN COLLECTION OF EAST COAST OF UNITED STATES

A.B. WILLIAMS, Univ. of North Carolina, Institute of Marine Science, *Morehead City, North Carolina* 28557

A curated and catalogued collection of crustaceans is maintained for research, teaching and systematic use. Species consist of estuarine and ocean crustaceans with emphasis on the North Carolina coastal waters.

SUPPORTED BY University of North Carolina

5.0482, ENERGETICS OF PALAEMONETES PUGIO AND THE WEEDBED COMMUNITY OF SOUTH CREEK ESTUARY

L.W. WOOD, Univ. of North Carolina, Graduate School, *Raleigh, North Carolina* 27600

00NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

5.0483, THE DEVELOPMENT OF HATCHERY TECHNIQUES TO AID IN THE PRODUCTION OF ECONOMIC MOLLUSKS

W.P. BREESE, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

Objectives--(1) To develop methods for the culture of larval clams and oysters in hatcheries. (2) To determine the optimum conditions for artificial seeding of clam and oyster grounds. (3) To utilize the hatchery techniques developed for the propagation of exotic bivalves for introduction into selected habitats. (4) To train shellfish biologists for careers in the culture and production of economic mollusks.

Initially, attempts will be made to spawn, fertilize and rear native clams and oysters from the egg to the seed stage. Simultaneously, attempts will be made to isolate and culture exotic and native algal forms for food for the developing larval mollusk. When techniques for the mass production of mulluscan seed have been developed, studies will be conducted to determine the best time, age, habitat type and density for planting each species of bivalve seed. Each planting procedure will be evaluated by survival and growth studies. In the conduct of this research, graduate students will receive training that will assist them in the preparation for careers as shellfish biologists.

SUPPORTED BY Oregon State Government

5.0484, ECONOMICS OF MARKETING DUNGENES CRAB

J.G. YOUDE, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

Objectives: 1. Describe the marketing channels for Dungeness crab. 2. Recommend changes that would increase efficiency in Dungeness crab marketing. 3. Determine relations between the Pacific Coast Dungeness crab industry and the Alaska King crab industry. 4. Specify relations between levels of production, products marketed, and prices received by fishermen and processors. 5. Evaluate the potential for industry promotion programs.

Procedure: A descriptive study will be conducted to determine the salient characteristics of the Dungeness crab industry. Data from that industry and from the Alaska King crab industry will be analyzed to determine relations between production prices, promotional activities, and other selected variables in the two industries.

SUPPORTED BY Oregon State Government

5.0485, NEURAL MECHANISMS OF LEARNING AND BEHAVIOR

M.E. LICKEY, Univ. of Oregon, Graduate School, *Eugene, Oregon* 97403

The project consists of a combined program of behavioral and neurophysiological experiments focused on the problem of learning. The strategy is to exploit the comparatively simple nervous system of the marine gastropod Aplysia for the purpose of achieving a fine grained analysis of neural systems mediating learned behaviors. In one group of experiments we are studying a circadian rhythm of activity in a single identifiable neuron in the parietovisceral ganglion. Of primary interest is the extent to which the rhythm can be entrained to various environmental photoperiods and the extent to which the rhythm is endogenous to a single cell. In another group of experiments we are attempting a synaptic analysis of a behavior which has been shown to be susceptible to modulation by past experience. Specifically it has been found that the food selection responses of Aplysia are governed to some extent by the animal's past experience. We are now trying to identify specific neurons which are involved in this response with the hope of eventually detecting changes in neuronal physiology which are the result of the training experience.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0486, CONTROLLED REARING OF DUNGENESS CRAB LARVAE

P.H. REED, State Fish Commission, *Newport, Oregon* 97365

The objective of this phase is to develop methods for hatching and rearing crab larvae under controlled laboratory conditions and describing their larval stages. A trip to California will be made to view the systems used by California Department of Fish & Game biologists to raise both crab and shrimp larvae and problems will be discussed. Equipment will first be purchased and tested. Egg bearing female crabs will be obtained and held in aquaria. As the eggs near hatching stage and animals will be transferred to self-contained sea-water systems to avoid larvae loss. Antibiotics and ultra-violet light will be tried for control of bacteria. Separate groups will be fed brine shrimp larvae, mussel larvae, or barnacle larvae, and growth and survival compared. Each stage of crab egg and larval development will be photographed and described. This phase should be completed by June 30, 1966. The research will be done at the Oregon State University Marine Science Center, Newport, Oregon.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Oregon State Government

5.0487, STUDY ON THE DISTRIBUTION AND ABUNDANCE OF PINK SHRIMP, PANDALUS JORDANI IN THE PACIFIC OCEAN OFF OREGON

G. MILBURN, State Fish Commission, *Portland, Oregon* 97201

This study will undertake to locate and define the major pink shrimp (Pandalus jordani) populations off the Oregon coast, to collect information on the biology and life history of these shrimp, and to develop techniques for studying population dynamics that will be usable in maintaining the maximum level of shrimp production compatible with sound management principles.

Offshore cruises of 30 days duration will be made during March of each year to delimit areas and numberical abundance of pink shrimp, and to collect biological data on age composition, fecundity, and sex composition prior to commencement of fishing. During the commercial fishing season, interviews and intensive sampling of catches will be made to monitor and correct any changes to the resource caused by fishing. Post-season cruises during October will be made to gather data to compare with the spring and summer samples and to use as a method of predicting abundance for the following year. Both commercial and experimental gear will be used to collect field data.

During the cruises and field season, fish stomachs will be examined to determine the extent of predation of the pink shrimp.

The project will take place off the coast of Oregon between the Columbia River and the Oregon-California border and at the ports of Astoria, Newport, Coos Bay, and Brookings. Personnel directly involved will be Jack Robinson, Aquatic Biologist 2, and an unfilled Senior Aquatic Biologist 1.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Oregon State Government

5.0488, MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST

C.D. SNOW, State Fish Commission, *Portland, Oregon* 97201 (14-17-0001-1895)

Summary of Proposed Work: The Oregon Fish Commission is continuing the oyster mortality monitoring program begin in 1966 with slight changes to conform with the recommendations of the team of experts which reviewed the program in 1968. Sampling stations will be maintained in Tillamook, Yaquina and Coos Bays.

In Yaquina Bay, the number of sampling stations will be reduced from six to three to permit more intensive monitoring of both native and Pacific oysters. Observations will be made every two weeks, and samples will be collected every 4 weeks. Those and dead or abnormal oysters will be sent to the University of Washington for histological examination.

In addition to the sampling stations in Yaquina Bay, an observation station will be established at the dock of the Marine Science Center. Observations will be made each working day. Dead or moribund animals will be collected for histological examination.

There will be one station at Tillamook and Coos Bays. Sampling will be monthly with collections for histological examination from the control lots and the adjacent beds.

Water quality measurements at Yaquina Bay will include temperature, salinity, dissolved oxygen and turbidity plus supplemental information from the Federal Water Pollution Control Administration and Oregon State University. At Tillamook and Coos Bays measurements of temperature, salinity and dissolved oxygen will be taken during each sampling visit.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0489, MANAGEMENT OF OREGON DUNGENESS CRAB RESOURCE

C.D. SNOW, State Fish Commission, *Salem, Oregon*

Purpose: Regulation of commercial and personal-use fishery to obtain maximum sustained yield.

Location: Headquarters are at Newport, Oregon. Work is done along the entire Oregon coast.

Methods: Crab landings are sampled at all major ports for condition, size, landing trends and fishing effort. Small populations of adult and immature crabs have been tagged annually to obtain information on life history and migration of this species.

Results: Results are applied to regulating harvest and to increase our basic knowledge of life history of Dungeness crab.

Reports: Monthly and annual progress reports. Catch statistics are published in reports of the Pacific Marine Fisheries Commission.

Publications: Snow, C. D. and E. J. Wagner. 1965. Tagging of Dungeness Crabs with Spaghetti and Dart Tags. Fish Comm. of Ore., Res. Briefs, Vol. 11, No. 1, pp. 5-13.

SUPPORTED BY Oregon State Government

5.0490, NEUROPHYSIOLOGICAL MECHANISMS IN BEHAVIOR

S.B. BARBER, Lehigh University, Graduate School, *Bethlehem, Pennsylvania* 18015

The ultimate aim of this study is a complete analysis of a variety of mechanisms of arthropod behavior. Arthropod behavior is sufficiently complex for the analysis to be relevant to man yet largely stereotyped and thus more readily analyzed. The work will deal with all aspects of behavior: input mechanisms, integration, output and effector mechanisms. It will also probe structural and ultrastructural aspects as they are pertinent to the physiological analysis.

Initially the study will concentrate on two different organisms and on different aspects of the over-all problem in each. One of these will be the effect of walking leg proprioceptors on locomotary behavior in Limulus polyphemus, the horseshoe crab. Most of these proprioceptors were found and characterized by the senior investigator and his co-- workers and this information will be the starting point for the investigation. The other study will be on mechanisms of flight in giant water bugs (Heteroptera, Belostomatidae). Because they are unusually large insects the flight muscles, nerves and ganglia are generally readily accessible for experimentation. This was found to be true in an earlier study of these organisms by the senior investigator.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0491, LEARNING IN OCTOPUS

M.E. BITTERMAN, Bryn Mawr College, Graduate School, *Bryn Mawr, Pennsylvania* 19010

Brief Description of Research Project: Learning in Octopus will be studied with improved techniques. One set of experiments will deal with the effects of certain drive and reward variables on the acquisition and extinction of a simple instrumental response. A second set of experiments will deal with habit-reversal and probability learning in choice-situations. The grant provides for two round trips of the principal investigator and his research assistant to the Stazione Zoologica in Naples.

SUPPORTED BY U.S. National Science Foundation

5.0492, A SYSTEMATIC STUDY OF ENTOCYTHERID OSTRACODS

C.W. HART, Acad. of Nat. Sci. of Phila. , *Philadelphia, Pennsylvania* 19103

The investigators have been engaged on studies of entocytherid ostracods (grants NSF GB-1436 and GB-4197). Entocytherid ostracods, insofar as is known, inhabit the Noarctic region, where they and branchiobdellid oligochaetes are epizoic on freshwater crayfishes; the Paloarctic region, where they are epizoic on freshwater isopods; Australian region, where they are found on crayfishes and isopods; and the coastal waters of India, where one new species has been found on wood-boring isopods. Little is known concerning the affinities of entocytherid ostracods with free-living ostracods. Four genera of the family have now been monographed and published.

It is anticipated that the proposed study will result in monographic treatments of the remaining genera of the family. Monographic revisions (although somewhat out of date) and several subsequent regional or generic studies have been published in crayfishes and branchiobdellids, but few comparable works exist for the commensal ostracods. In recent years, a number of investigators have described new ontocythorids from various parts of North America, but most of these ostracods are known from fewer than a half-dozen localities, and the ranges of only four genera have been accurately delimited. In addition to collections already available, it is planned to obtain specimens from crayfish in South America, New Zealand, and Madagascar for comparative studies.

SUPPORTED BY U.S. National Science Foundation

5.0493, THE RHODE ISLAND HARD CLAM - QUAHAUG - INDUSTRY

A. HOLMSEN, Univ. of Rhode Island, Agricultural Experiment Sta. , *Kingston, Rhode Island* 02881

a) Determine the cost and returns in handraking and dredging, and analyze the labor force and its return per unit of effort. b) A study of dealers and wholesalers, their functions cost and returns, and marketing margins. c) An analysis to determine the price elasticity of demand at wholesale and ex-vessel by grade and season. d) Determine the cost of alternative methods of depuration and the cost of a hatchery program for seeding purposes.

Procedures: a) The purchase records for three medium-sized dealers in different locations of the Bay for the quahaug license year, 10/1/62 - 9/30/63, will be studied to determine the quantities delivered, price received, and number of days worked for individual handrakers and dredgers. An expected 130 records on handrakers and about 20 records on dredgers will be obtained and these fishermen will be contacted for information on cost, other occupation, etc. b) About 15 dealers in the state which handle significant quantities will be interviewed. The flow of quahaugs through the marketing channel will be followed to study the cost and returns on each level and the utilization of the catch. c) A price analysis will be carried out to obtain the price elasticities of demand for each grade of quahaug (chowders, cherry stones, little necks) at the wholesale and ex-vessel level for the winter and summer seasons. To obtain those by the use of secondary data will be tried, but some primary data for the analysis might have to be obtained through dealers and wholesalers. d) In cooperation with the Graduate School of Oceanography, budgeting of alternative biologically and technically feasible methods of depuration will be made, and information on the investment and cost of operation of presently existing, out-of-state quahaug hatcheries will be collected.

SUPPORTED BY Rhode Island State Government

5.0494, EVALUATE THE RESEARCH TECHNIQUES WHICH WILL BE EMPLOYED TO STUDY THE BASIC LIFE HISTORY OF THE RED CRAB (GERYON QUINQUEDENS)

G.W. GRAY, State Dept. of Nat. Resources, *Providence, Rhode Island*

The objectives of this phase of the red crab study are to evaluate the following techniques: (1) Measurements (2) Ageing of carapace (3) Holding studies (4) Marking experiments (5) Egg and larval studies (6) Sampling studies.

State of Rhode Islane, Department of Natural Resources, Division of Conservation, Marine Fisheries Unit, 150 Fowler Street, North Kingstown, Rhode Island will be the location where most of this phase work will take place.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Rhode Island State Government

5.0495, PRELIMINARY MODIFICATIONS AND CONTROL OF NATURAL GROWING AREA ENVIRONMENTS

S.B. SAILA, State Dept. of Nat. Resources, *Providence, Rhode Island*

Objectives: 1. Design and execute appropriate field plot designs to determine effects of mineral nutrients and substrate composition on the growth of juvenile hard clams (Mercenaria mercenaria), soft clams (Mya arenaria) and oysters (Crassostrea virginica). 2. Critically evaluate use of predator control fence, chemical predator control, and various culture techniques on survival.

Procedure: 1. Three factors, nitrogen, phosphorus and calcium are to be included in 8 treatment combinations in 3 replicates. 2. Plot size is 1/100 acrea for each 8 plots in 3 substrates. 3. All organisms will be individually marked for growth increment comparisons. 4. A complete analysis of various treatment combinations will be carried out.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Rhode Island State Government

5.0496, REARING AND SENSITIVITY STUDIES OF VARIOUS LIFE STAGES OF MARINE MACROINVERTEBRATES

G. MORRISON, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab., *Wakefield - Kingston, Rhode Island* 02881

The goal of this project is to determine the relative sensitivity of various stages of marine macroinvertebrates to specific materials and the evaluation of marine invertebrates as indicators of extreme levels of known toxicants over extended periods.

This work will eventually be incorporated in broader areas of research to determine the effects of these toxicants upon growth, reproduction, activity, metabolism, and the activity of hormones and enzymes.

The organisms studied to date are the first larval stages of Callinectes sapidus, Carcinus maenas, Uca pugilator (?), and Palaemonetes pugio and their reaction to various levels of copper.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0497, HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE INVERTEBRATES

P.P. YEVICH, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab., *Wakefield - Kingston, Rhode Island* 02881

Histopathologic studies will be conducted on various species of marine invertebrates: quahogs, soft shell clams, oysters, lobsters, shrimp, blue crab, etc. after exposure to various pollutants. Studies are presently being conducted in cooperation with the Northeast Marine Health Sciences Laboratory on quahogs (Mercenaria mercenaria) which have been exposed to 0.05 and 0.025 ppm of Cu, 0.2 ppm of Zn, 0.2 and 0.1 ppm of Cd and 0.05 and 0.1 ppm of Cr.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0498, STUDIES ON THE PROTISTAN CAUSING MALPEQUE DISEASE

J.G. MACKIN, Texas A & M University System, Graduate School, *College Station, Texas* 77843

Previous studies of the organism causing Malpeque disease of oysters have shown (1) that the causative agent is complex of species of Labyrinthomyxa Duboscq. (2) none of the species has been described, and (3) experimentation has shown that all are highly pathogenic to oysters and can be transmitted. Studies in progress now are aimed at development of knowledge of distribution, characterization of species, and studies on pathogenicity to the several oyster hosts.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0499, PREDICTING COMMERCIAL SHRIMP ABUNDANCE (SHRIMP DYNAMICS PROGRAM)

K.N. BAXTER, U.S. Dept. of Interior, Biological Laboratory, *Fort Crockett - Galveston, Texas*

Measures of the relative abundance of postlarval and juvenile brown and white shrimp have been obtained from Galveston Bay, Texas, since 1960. Analyses of these data have shown that predictions of commercial supplies are possible, but improvements in past measures are needed. Research objectives are to examine and define the relations between the desnity of postlarval shrimp, the abundance of juveniles, and the size of the mature crop available to the commercial fishery.

Studies are underway to (1) develop a pumping system that will obtain small samples of postlarvae at frequent intervals or continuously and, thereby, reduce the variability of postlarval indices; and (2) collect postlarval brown shrimp offshore in winter months in an attempt to develop an earlier index to the crop of adult shrimp available between May and July.

Laboratory studies include experiments to determine behavioral characteristics of postlarvae that may effect their vulnerability to sampling gear, including preferred bottom material for burrowing when temperatures are low, and vertical movements related to changes in temperature, light, and salinity.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0500, 131.116B - LARVAL CULTURE (SHRIMP AQUACULTURE PROGRAM)

H.L. COOK, U.S. Dept. of Interior, Biological Laboratory, *Fort Crockett - Galveston, Texas*

There are four native species of penaeid shrimp--white, pink, brown, and the seabob--that appear suited for culture. All have been hatched and reared to the postlarval stage from females that were fertilized naturally offshore, but spawned in the laboratory. The principal problem remaining is that of growing algal food in sufficient quantity to feed vast numbers of larvae. Research is in progress that includes development of a technique to permit large-scale culture of algae used as food for larval shrimp.

Also, laboratory-hatched and reared penaeid larvae are being held under controlled conditions to determine the effects of various factors (i.e., food, light, temperature, and salinity) on their growth and survival.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0501, EXPERIMENTAL SEEDING (SHRIMP AQUACULTURE PROGRAM)

T.J. COSTELLO, U.S. Dept. of Interior, Biological Laboratory, *Fort Crockett - Galveston, Texas*

Following a 3-year study of the ecology of the waters in Florida Bay and Keys, it is apparent that only a portion of the suitable nursery areas are used by shrimp. Project objectives are to rear large numbers of shrimp from eggs spawned in the laboratory and seed underutilized nursery grounds.

Selected areas will be enclosed and stocked with laboratory-reared postlarvae. By systematic measurements of shrimp populations and physical features, rates of growth and survival of shrimp in different population densities will be related to physical conditions. The ultimate goal will be to determine the carrying capacities of nursery grounds and maintain an optimum level of shrimp population by seeding.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0502, RECONNAISSANCE ECOLOGIC SURVEY OF THE CONTINENTAL SHELF AND UPPER SLOPE (GULF OCEANOGRAPHY PROGRAM)

J.R. GRADY, U.S. Dept. of Interior, Biological Laboratory, *Fort Crockett - Galveston, Texas*

To better understand the behavior of shrimp, their migration, and abundance, it is essential to acquire a thorough knowledge of the natural environment. Any ability to predict crop abundance and distribution depends not only on an extensive knowledge of the variables in the natural environment of the estuaries and the waters overlying the continental shelf, but also of the character of the sea floor.

It is the purpose of this project to define the fundamental properties of the physical and chemical sedimentary environment on the shelf, and to determine what features of the sediments and bottom water are relevant to the prediction of shrimp populations. Data will be correlated with all available information on shrimp distribution and abundance to evolve a formula, in conjunction with Circulation Dynamics Project and the Shrimp Dynamics Program, to aid in forecasting the marine environment over the shelf.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0503, POPULATION DYNAMICS (SHRIMP DYNAMICS PROGRAM)

R.A. NEAL, U.S. Dept. of Interior, Biological Laboratory, *Fort Crockett - Galveston, Texas*

Present means for managing shrimp fisheries in the Gulf of Mexico have evolved without the benefit of a firm knowledge of the population dynamics of the species. Project objectives are to obtain direct measures of shrimp growth, mortality, and movements, by means of mark- recapture experiments, and to determine the feasibility of deriving indirect estimates of fishing mortality from measures of total mortality and fishing intensity. Additionally, the relation between the rates of fishing and stock size as well as the optimum levels of fishing are being investigated using commercial landing statistics.

Studies on the comparative fishing power of shrimp vessels are formulated to more accurately assess mortality generated by commercial shrimp fleets. The selective characteristics of commercial shrimp trawls and the comparative fishing mortality that would result from mesh regulations will be examined in an effort to develop models to predict short- and long- term effects of regulations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0504, JUVENILE AND ADULT CULTURE (SHRIMP AQUACULTURE PROGRAM)

R.S. WHEELER, U.S. Dept. of Interior, Biological Laboratory, *Fort Crockett - Galveston, Texas*

The rapid growth rate and high economic value of shrimp has led to considerable interest in the possibility of pond-type shrimp culture. Research is designed to determine the feasibility of growing shrimp economically under seminatural conditions. More specifically, studies are being made to determine those ecological factors that affect growth and survival of shrimp in ponds. Once determined, methods will be developed for controlling or modifying those factors to insure maximum production of shrimp.

Additional efforts are being made to determine and create conditions essential for mating and spawning of shrimp under laboratory conditions. The ultimate goal will be to initiate genetic studies that will result in a fast-growing, hardy shrimp suitable for pond culture.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0505, FOOD AND EXPERIMENTAL ENVIRONMENTS (SHRIMP AQUACULTURE PROGRAM)

Z.P. ZEINELDIN, U.S. Dept. of Interior, Biological Laboratory, *Fort Crockett - Galveston, Texas*

By means of controlled experiments, project objectives are to determine optimum conditions for growth, survival, and reproduction of shrimp in artificial environments. Activities include (1) development of a prepared food for use in shrimp culture; (2) determination of the digestive enzymes of shrimp; (3) documentation of which naturally occurring food organisms shrimp prefer; and (4) development of methods of culturing food organisms that support favorable shrimp growth.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0506, NITROGEN METABOLISM IN MOLLUSCS

J.W. CAMPBELL, Rice University, Graduate School, *Houston, Texas* 77001

An investigation of excretory nitrogen metabolism in terrestrial and aquatic pulmonate gastropods. In addition to acquiring basic information on the biology of these organisms, some of which are important vectors of parasitic diseases, the project has as an objective the elucidation of the basic metabolic adaptations that have occurred in the evolutionary transition between the terrestrial and aquatic environments. Of specific concern are the physiological roles of the pathways for purine biosynthesis, arginine biosynthesis and arginine degradation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0507, REAR AND DESCRIBE LARVAE OF BIVALVES

P. CHANLEY, Virginia Inst. of Marine Sci. , *Gloucester Point, Virginia* 23062

The larval development of most bivalve species has never been described. The purpose of this project is to describe as many as possible. Thus far descriptions of 4 species (Barnea truncata, Rangia cuneata, Noetia ponderosa, Lyonsia hyalina) have been published. Descriptions of two more (Cyrtopleura costata and Donax variabilis) are in press. A detailed comparative description of 23 species is also in press. Laboratory culture of two more species (Montacuta percompressa and Amygdalum papyria) has been completed. Another species, Brachidontes recurvus, is currently being cultured.

Larvae of several other species have also been cultured but not successfully reared to metamorphosis (Tagelus plebeius, Macoma tenta, Macoma phenax, Anadara ovalis).

Future plans involve continued work with local species and also with selected exotic species that are of particular interest.

SUPPORTED BY Virginia State Government

5.0508, DISTRIBUTION AND ABUNDANCE OF OYSTER DRILLS (UROSALPINX CINEREA) IN THE JAMES RIVER, VIRGINIA

D.S. HAVEN, Virginia Inst. of Marine Sci. , *Gloucester Point, Virginia* 23062

Using drill traps, dredged samples, and caged drills, data have been obtained on distribution and mortality rates of oyster drills in relation to temperature and salinity, in the James River, Virginia.

SUPPORTED BY Virginia State Government

5.0509, ULTRASTRUCTURE OF EARLY CLEAVAGE STAGES IN THE EGG OF LYMNAEA SP

F.O. PERKINS, Virginia Inst. of Marine Sci. , *Gloucester Point, Virginia* 23062

The fine structural changes in fertilized eggs of Lymnaea sp. prior to and during first and second cleavages was investigated. Microtubular involvement in the cortical region and branching microtubules were observed. Yolk platelet biogenesis and degradation was described.

SUPPORTED BY Virginia State Government

5.0510, MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST

C. LINDSAY, State Dept. of Fisheries, *Olympia, Washington* (14-17-0001-1900)

The Department of Fisheries will conduct field and environmental studies on mass mortalities affecting Pacific Oysters as set forth in the following phases: Phase I. Monitoring of Mortality and Growth of Pacific Oyster Seed from 5 Source Areas. 1. Japan, Hokina (High mortality area). 2. Japan, Mongoku-ura (Low mortality area). 3. Washington, Dabob Bay. 4. Washington, Willapa Bay. 5. Canada, Pendrell Sound. Phase II. Float Studies, Eld Inlet. Mortality, growth, fatness, glycogen and histology of 1965 year class (planting) oysters from beds of LeRoy Patterson. Phase III. Transplant Study. Patterson 1965 year class (planting) oysters previously planted at Quilcene Bay, Eld Inlet (Matthews) and Eld Inlet (Brenners) will be transplanted from each station to the other two. Mortality, growth, fatness, glycogen and histology will be monitored. Phase IV. Mortality Monitoring. 1966 (planting) year class Patterson oysters at Case, Eld, and Totten Inlets and Oakland and Quilcene Bays. Phase V. Commercial Oyster-bed Mortality Monitoring. Northern, central, and southern Puget Sound, Grays Harbor, and Willapa Bay. Phase VI. Cultural Experiments to Circumvent Mortalities. 1967 Japanese year class seed planted and reared in Oakland Bay will be transplanted to North Bay. Commercial stocks (1967) reared in North Bay will be used for controls. Phase VII. Hydrographic Sampling. 1. Continuous recording of water temperature adjacent to oyster stocks at the sampling stations in Quilcene Bay, Eld Inlet (Matthews), and Eld Inlet (Brenners). 2. Eld Inlet. A. Center line of inlet. Vertical distribution of salinity, temperature, O2, chlorophyll and phosphate. B. Shallow oyster beds. Photosynthetic rate, chlorophyll, phytoplankton species, pH, temperature, salinity, O2, total and inorganic phosphates, nitrate, nitrite ammonia, soluble and particulate carbohydrates and organic nitrogen, lipids. 3. Quilcene Bay, Oakland Bay, Totten Inlet, and Case Inlet. Salinity, temperature, O2, chlorophyll, phytoplankton and phosphate. Phase VIII. Standardization of Data Collection Processing and Analysis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0511, INSPECTION OF OYSTER SEED - NEW ASIATIC SOURCES

C. LINDSAY, State Dept. of Fisheries, *Olympia, Washington*

Phase I - Objectives: Investigate possibilities of obtaining disease from Pacific oyster seed, where present Japanese sources are insufficient to maintain Washington's oyster industry at present levels.

Procedures: Investigator experienced in Japanese oyster seed inspection will proceed to Japan, Korea, and Taiwan, and ascertain prospects for obtaining seed from new sources. Prospects for quantity collection of oyster seed meeting Washington specifications will be reviewed with Asiatic oyster growers. Where likely seed sources are found, sample shipments will be made to Washington's Point Whitney Shellfish Laboratory for quarantine for further determination of disease status. Information on results and general overall prospects of new seed sources will be circulated to oyster industry of the Pacific Coast.

Work Schedule: Investigator will determine schedule of departure based upon available passage to Japan, obtain passports and inoculations against human Asiatic diseases. Departure will be shortly after July 1, 1966, and return approximately September 1,1966.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5.0512, OYSTER FATNESS STUDY

C.S. SAYCE, State Dept. of Fisheries, *Olympia, Washington*

The objective of this phase is the development of fat oysters thereby increasing the production of oysters, through supplemental feeding techniques. This phase will be a laboratory study using trayed oysters divided into two groups of experimentally fed and non-fed controls with two control stations of oysters on tidelands near the laboratory. Each experiment will use 400 oysters in the laboratory, 200 oysters at each of two outside control stations, and will be of 32 days duration. The experimental design was developed with the aid of Dr. Douglas G. Chapman, University of Washington, statistical consultant for the project. Data collections will include temperature salinity turbidity, pH, and concentrations of the supplemental food at inlet and outlet. Growth of oysters will be followed by volumetric observations every four days and condition of oysters will be determined by Condition Index, Total Solids and Glycogen content amply. Experiments will be run during summer, fall, winter, and spring periods of 1966-1967 to establish seasonal growth and fatness data.

The work will be done at the Willapa Shellfish Laboratory located in the community of Nahcotta, on Willapa Bay in Pacific County Washington.

(Part 1 of 3)

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5.0513, COLLECTION OF JUVENILE MIGRANTS FROM RIVERS AND STREAMS

D.W. BATES, U.S. Dept. of Interior, Fish Passage Res. Program, *Seattle, Washington*

Anticipating that certain types of hydro-electric developments may either destroy large numbers of young migrant fish or may be impassable, a major research effort is being made to find practical and economical methods of collecting these young fish from rivers and streams before they reach the areas of danger. Methods of fish guidance and collection presently in use are only partially successful, or not applicable to large projects, or overly expensive. Research will be directed toward improving the efficiency of guiding techniques that have shown promise in the past, such as electricity, louvers, and lights; exploring the possibilities of more effective combinations of techniques; and developing new concepts of fish guidance and collection that would use a minimum of structure in the water. Facilities and methods for holding, handling, and transporting fingerlings will be investigated.

Four field stations are now in operation for such testing. Primary features of these stations are the flume installations which provide flexibility, wide range of velocity control, ease of fish observations and enumeration, and the testing of wild fish in as near to natural conditions as possible. Since the beginning of this project considerable advance has been made in the deflection or guidance of young migrants by means of flow accelerations and decelerations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0514, SHELLFISH EXPLORATIONS

C.R. HITZ, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Seattle, Washington* 98102

Shellfish exploration is concerned with benthic invertebrate populations. The objectives are to define, in time and space, the quantitative and qualitative distribution of aquatic benthic invertebrate resources having a potential for commercial utilization, and to provide an appraisal of these resources.

Preliminary work was begun in FY 1968 to develop a suitable clam dredge for assessment studies. Emphasis in FY 1969 will be to continue to assist the gear research unit in developing a clam dredge which can be used in offshore areas. Assessment of clam stocks off Oregon and Washington will follow. Marine Invertebrate Explorations, FY 1969.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0515, BARNACLES OF THE EASTERN PACIFIC

D.P. HENRY, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

This investigation is a continuation of the studies on the barnacles of the Panama Pacific Province initiated with assistance from NSF grant GB-1684. The Panamic-Pacific Province is now generally recognized as that region between the head of the Gulf of California and Cabo Blanco in northwestern Peru.

Of particular import are the proposed studies of the barnacle species of Costa Rica and Ecuador and the work on the complemental males in sessile barnacles. In conjunction with studies on complemental males in sessile barnacles, the life history of a related species with indications of aberrant sexual development will be pursued. The proposed research also includes provision for the completion of the study of the genus Chthamalus from the Eastern Pacific.

An attempt will be made to determine what, if any, relationship the barnacle fauna of the Panama-Pacific Province has with that of the Antillean and/or Indo-West Pacific Provinces.

SUPPORTED BY U.S. National Science Foundation

5.0516, SYSTEMATICS OF MARINE SYMBIOTIC CRUSTACEA FROM INVERTEBRATES

P.L. ILLG, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The parasitic forms of the Copepoda, running now to several thousand species described, present a significant systematic problem. The broad purpose of this proposal is to continue explorations in expanding approaches in the systematics of copepods. Basic monographic studies have been proceeding and it is proposed to continue these. Since all the forms studied are associated in symbiosis with various invertebrates and the assemblage shows a graduated series of interactions between the symbionts, some basic questions in symbiosis and parasitism are also raised. Extended studies of life histories are invoked and comparisons through all the types of taxonomic data are being accumulated with a long-range view to critical evaluation of taxonomic characters. A recently developed extension is similar study of a local member of the Cirripedia (Ascothoracica) with a principal objective evaluation of claims of higher levels of relationship, particularly between Copepoda and Cirripedia.

SUPPORTED BY U.S. National Science Foundation

5.0517, RESEARCH ON INDO-WEST PACIFIC MARINE MOLLUSKS OF THE FAMILY CONIDAE

A.J. KOHN, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The next three years of research on this long-term study of systematics of Conus will concentrate on natural populations of tropical Indian Ocean Islands, where large numbers of sympatric species occur, and on continuation of studies of the type specimens and identity of the described species. Field data and material derive from participation of the principal investigator in the Yale Seychelles Expedition and International Indian Ocean Expedition. The taxonomic studies will be pursued primarily at the U.S. National Museum.

The main aspects to be investigated are: 1) classification, population density, species and habitat diversity, relative abundance, and interspecific differences in ecological characteristics of Conus populations on Indian Ocean coral reefs; 2) comparative morphology and morphometry of radula teeth; 3) chronological study of type specimens and identity of species of Conus described during the 18th century; 4) application of objective methods to the taxonomic study of the genus; 5) tanomomic studies of material submitted for identification from collections of the International Incian Ocean Expedition and other sources.

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SUPPORTED BY U.S. National Science Foundation

5.0518, COLUMBIA RIVER STUDIES

A.H. SEYMOUR, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

Of the four studies greatest attention will be given to the effects of 65Zn, 51Cr, and 90Sr on oyster larvae. Oysters are brought to the spawning condition in the laboratory by manipulation of water temperature. Upon fertilization the eggs are placed into containers each with two liters of water of various radionuclide concentration. The experiment is terminated two days after fertilization at which time the oyster is in the straight-hinge larvae state. Later the larvae are classified as normal and abnormal and counted. Information from this experiment is related to waste disposal, oyster growing and to the controversy concerning the effects of radionuclides upon pelagic eggs and larvae of marine fishes. In other studies the geographical limit of distribution of Columbia River water along the Washington coast will be determined by monitoring 65Zn in mussels; a compilation of Hanford produced radionuclides in marine organisms will be prepared; and, the biological half-life of zinc in oysters will be determined by use of 65Zn and a small animal whole body counter. After feeding 65Zn to the oysters for a day or two only at the beginning of the experiment 65Zn measurements will be made periodically of individual oysters living in a natural environment except for the time they are transferred to and from laboratory for whole body counting.

Although the above studies are a new program, prior work does provide some pertinent information. Mussels along the outer Washington coast have been monitored for 65 Zn but now the sampling will be extended into the Straits of Juan de Fuca and Puget Sound. Much information from several sources is available on Hanford produced radionuclides in marine organisms. These data will be compiled and supplemented by a limited amount of new information. Also in the past the biological half-life of zinc in oysters has been determined by destructive sampling from lots of oysters transferred between 65Zn contaminated and non-contaminated waters, Willipa Bay and Puget Sound respectively. This time the loss of 65ZN in individual oysters will be followed as the oyster will not need to be sacrificed to make the 65Zn measurement.

SUPPORTED BY U.S. Atomic Energy Commission

5.0519, STUDIES IN OYSTER PATHOLOGY

A.K. SPARKS, Univ. of Washington, Graduate School, *Seattle, Washington* 98122 (14-17-0001-1377)

The Oyster Pathology Laboratory of the College of Fisheries will process and examine tissue from the expanded field study of the Washington State Shellfish Laboratory and the Oregon Fish Commission oyster mortality field investigation in order to investigate the reaction of oyster tissue to various types of injury.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0520, EPIZOOTICS IN EXPERIMENTAL MARINE SHELLFISH POPULATIONS

A.K. SPARKS, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

Maintenance of experimental populations of Pacific oysters, native oysters, and bay mussels in float and bed stations will be continued in California, Oregon and Washington for determination of mortality and growth rates in the various species at the different locations. Living and dying bivalves will continue to be fixed and processed for microscopic examination for the presence and pathological effects of possible pathogenic organisms and a more sophisticated computer program will be utilized to determine the relationships of possible pathogens and mortalities.

Attempts will be made to culture in vitro the microorganisms, probably Vahlkampfia sp., responsible for heavy mortalities of Pacific oysters in Humboldt Bay, California to elucidate its life history, facilitate specific identification, and enable us to initiate infection experiments. Life history studies, through in vitro culture, of Mytilicola orientalis will be continued, particularly to determine the infective stage.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5E. ANIMALS, OTHER

(Birds, Mammals, and Unspecified Invertebrates and Vertebrates)

5.0521, MARINE BIOLOGICAL INVESTIGATIONS - NEKTON OF INSIDE WATERS OF SOUTHEASTERN ALASKA

J.C. QUAST, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

Goals are to identify the common nekton organisms and monitor the seasonal and geographic changes in density distribution of their populations in the Lynn Canal-Chatham Strait fjord. Eight stations along the fjord have been sampled with an Isaacs-Kidd trawl at the surface and at 100 meters each season over a period of 2-1/2 years. Data on fishes and invertebrates are now being processed.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0522, SEAL BIOLOGY AND HARVEST

J.J. BURNS, State Dept. of Fish & Game, *Juneau, Alaska*

Objectives: 1. To obtain current information about the magnitude, species composition, and characteristics of the seal harvest in northwest Alaska as part of a continuing effort to determine status and trend of this resource. 2. To investigate the various aspects of reproduction in the ringed, harbor, and ribbon seals. 3. To continue obtaining as much information concerning the natural history of seals, as possible. 4. To attempt to identify the environmental conditions affecting abundance and distribution of the various seals (bearded, ringed, harbor and ribbon) when they occupy their winter range. 5. To investigate the interspecific relationships among the phocids of this area. 6. To continue with the work of locating harbor seal population centers and attempting to determine patterns of dispersal.

Procedures: 1. The magnitude and characteristics of the seal harvest will be determined by analysis of bounty records, examination of scalps submitted for bounty, observation at some of the major hunting sites (in conjunction with Job F-2), and collection of specimens for determining age composition. 2. Specimens collected during field work associated with other jobs will provide the material for a study of the various aspects of seal reproduction. 3. Information about the life history of seals will be obtained through observation of these animals, and consolidation of the results of other aspects of investigation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Alaska State Government

5.0523, WALRUS BIOLOGY AND POPULATION

J.J. BURNS, State Dept. of Fish & Game, *Juneau, Alaska*

Objectives: 1. To continue accessing walrus population status and trend in light of recent harvests which have been greatly affected by both hunting regulations and management efforts. 2. To obtain information on walrus herd composition, movements and distribution throughout the year, especially during the winter months, and attempt to more accurately determine the important factors affecting distribution. 3. To investigate the various facets of walrus behavior. 4. To investigate all phases of walrus biology that would enhance our present knowledge of the various aspects of reproduction. 5. To attempt to undertake aerial survey work which would augment and provide an invaluable check on the walrus population work undertaken during Fiscal Year 1967.

Procedures: 1. Information on the present walrus population status and trend will be obtained through observation of the herds at the major walrus hunting sites, by evaluating records of hunting effort and success, by obtaining information on the proportion of animals in the various age and sex groups, by selective sampling of walrus taken by the hunters, and by evaluating the results of the proposed aerial survey (Objective No. 5). 2. Observation throughout the year, at the different hunting sites, will provide current information about herd composition, distribution, movements, and the factors affecting movements. 3. Attempts will be made to analyze behavior of the various segments of the herd during 1) the spring migration of nursery herds through the Bering Strait area and 2) the adult male walrus utilizing the Walrus Islands during July and August. 4. Continued effort will be devoted to the study of walrus biology, especially reproduction. Information will be obtained from biological specimens acquired at the field stations, in conjunction with Job F-2. 5. Pending cooperation from the U.S.F.W.S., an aerial survey will be undertaken during the late winter or early spring of 1968.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Alaska State Government

5.0524, BREEDING AND MATERNAL BEHAVIOR AMONG THE STELLER SEA LION

D.R. KLEIN, State Dept. of Fish & Game, *Juneau, Alaska*

Objectives: 1. To investigate aspects of the breeding biology and behavior of the sea lion with particular emphasis on the timing of breeding in relation to parturition. 2. To study the behavior of cows and pups on breeding rookeries as related to pup desertion and survival, frequency of nursing and development of pups.

Procedures: 1. Observations will be made on breeding rookeries prior to, during and following parturition to fulfill the above listed objectives. 2. Wherever possible, attempts will be made to determine the effects of commercial harvest of sea lions on breeding patterns, pup desertion and survival and general behavior at the rookeries.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Alaska State Government

5.0525, HAIR SEALS

E. KLINKHART, State Dept. of Fish & Game *Juneau, Alaska*

Objectives: 1. To obtain information on the timing of the molt. 2. To determine patterns of dispersal and obtain known age specimens. 3. To determine the current abundance and location of major pupping areas. 4. To monitor commercial operations engaged in the harvesting of seals. 5. To maintain current information on the response of hair seal populations to harvesting.

Procedures: 1. Seal hunters and buyers will be interviewed to determine the general period of the molt and hide quality. Pelage samples will be collected from hunters and buyers and selective collecting will be employed to gain a better understanding of the molting process. 2. Seal pups will be tagged on specific rookeries to secure data on movements and known age specimen material for productivity and aging studies. This phase is of relatively long duration due to the tagging and recovery activities involved. 3. Aerial surveys and hunter and buyer interviews will be utilized to determine the current abundance and location of pupping areas and seal populations. Various aerial survey techniques will be investigated to establish methods for accurate population counts. 4. Harvest operations on pupping areas at Tugidak Island and along the Alaska Peninsula will be monitored. The harvest of adult seals will be monitored by accompanying seal hunters aboard sea going vessels. Specimens will be collected for breeding biology information. 5. Extent and location of harvest will be reconstructed from bounty records and buyer interviews and then related to present seal populations and current harvest trends.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Alaska State Government

5.0526, SEA LIONS

J. VANIA, State Dept. of Fish & Game, *Juneau, Alaska*

Objectives: 1. To determine factors relating to the breeding biology and productivity of sea lions. 2. To classify rookery and hauling out grounds in accordance with the type of animals frequenting them. 3. To obtain data on the movement of sea lions. 4. To obtain information on the timing of the first molt of pups. 5. To monitor all commercial operations engaged in the harvesting of sea lion pups and adults.

Procedures: 1. Reproductive tracts of females will be collected during commercial harvesting activites. Large numbers of pups will be tagged in order to obtain known age specimens. 2. Classifications of pupping rookeries, bachelor hauling grounds, nursery and breeding rookeries will be accomplished by ground and aerial surveys. 3. Detailed observations will be made on specific pupping rookeries where pups and adults will be tagged for the purpose of observing their subsequent dispersal. 4. Pelage specimens from pups will be collected at intervals during the year to determine the timing of the first molt. 5. Harvest operations on rookeries will be monitored to assure wise utilization of the resource and to prevent overharvesting. Reproductive tracts and lower jaws of adult animals harvested will be collected for breeding biology information.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Alaska State Government

5.0527, BELUGA WHALES

J. VANIA, State Dept. of Fish & Game, *Juneau, Alaska*

Objectives: To study the reaction of belugas to various types of underwater sound transmissions. To gather basic life history data.

Procedures: 1. Tape recordings of killer whale sounds and ultra high frequency sounds will be transmitted under water to determine if the movement of belugas can be influenced by such transmissions. 2. Selective collections of reproductive tracts and stomachs will be made to provide information on age, breeding biology and food habits.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Alaska State Government

5.0528, SEA OTTER

J. VANIA, State Dept. of Fish & Game, *Juneau, Alaska*

Objectives: 1. To determine population abundance, distribution and trends of sea otter in the coastal areas from Prince William Sound to the Shumagin Islands. 2. To obtain information relating to the molt, breeding biology and food habits of the sea otter in selected parts of its range. 3. To refine techniques already developed for transplanting sea otters and to transplant animals to various sites in Southeastern Alaska.

Procedures: 1. Aerial surveys will be conducted to determine the general abundance and distribution of sea otter in the general areas indicated. Surface observations will be employed for more detailed studies in selected areas. 2. Direct observation and selective collecting will be employed. Pelt specimens will be collected to gain a better understanding of the time and nature of the molting process; and collections and examinations of the reproductive tracts will provide information on the breeding biology. Food habits will provide information on the breeding biology. Food habits will be studied by direct observations and by examination of stomachs. 3. Pens of various designs will be tested to determine the one best suited for holding sea otters while in transit. Several experimental releases of up to 30 animals will be made at selected sites in Southeastern Alaska.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Alaska State Government

5.0529, THE MORPHOLOGY, HISTOCHEMISTRY, AND MODE OF SECRETION IN THE VENOM GLAND OF SEA SNAKES

C.E. MAYS, Arizona State University, Graduate School, *Tempe, Arizona* 85281

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

5.0530, MORPHOLOGY AND PHYSIOLOGY OF THE HEART OF ECTEINASCIDIA TURBINATA

J.C. JONES, Bermuda Biolog. Sta. For Res. , *Saint George, Bermuda*

The present proposal is for spending approximately 45 days per summer at the Bermuda Biological Station for Research in order to study the following problems in the ascidian Ecteinascidia turbinata: (1) the histology of the heart and pericardium with different fixatives and stains, with special reference to innervation, (2) the relationship of body size to heart rate, (3) the influence of time after captivity on the heart rate, (4) the effects of differential pressure on different regions of the intact heart, (5) the effects of strong body contraction and prolonged siphonal closure on the heart rates, (6) the effects of puncturing different regions of the heart, (7) the effects of selected drugs on the heart rates, and (8) the effects of electrically stimulating the 'naturally' arrested hearts of otherwise normal and healthy tunicates.

SUPPORTED BY U.S. National Science Foundation

5.0531, TELEMETRY STUDIES ON MARINE BIRDS

H.H. VOGEL, Bermuda Biolog. Sta. For Res. , *Saint George, Bermuda*

Our knowledge of the distribution, migration routes, homing ability, feeding areas, etc. of most of the marine birds is extremely deficient. During the past few years, the use of telemetry and radio- tracking of both birds and mammals has advanced considerably, both in instrumentation, electronics, and methodology. The Yellow-billed Tropic Bird is the only common marine birds nesting on the island of Bermuda. Last spring we studied this species, using radioactive bands, to determine nesting and incubation habits of the adults. The method proved successful and will be continued this spring in further studies on care and feeding of the young. The objective of the present study is to place small radio transmitters on a small sample of the adult birds and follow them from their burrows in the limestone cliffs, by boat and/or plane, to determine their distribution, feeding grounds, homing abilities, and time at sea away from the nesting area.

The telemetry method, together with the radioactive work, should provide much useful information for this and other species. This proposal is fundamentally ecological, but has important contributions in the problems of homing and communication.

If the method proves successful on the Tropic-bird, we plan to place a small, disposable, radio-transmitter on one or more young Bermuda Cahows, petrels that are now almost extinct (23 pairs living). These birds nest only on Bermuda. The young leave their burrows at night, after long incubation periods, and do not return to land to nest for a period of four years. Little is known of where they go or what they do during this long pelagic life. Wingate has been studying their species for many years. We hope eventually to save the cahow from becoming another extinct bird.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0532, ECOLOGY OF STORM PETRELS

S. HARRIS, Humboldt State College, Graduate School, *Arcata, California* 95521

A project involving the banding of various species of Petrels mainly on nesting islands off shore of Trinidad, California.

Included is a study of the recapture of previously banded birds at the same nesting site.

This project has been carried on for four years and will continue indefinitely.

SUPPORTED BY No Formal Support Reported

5.0533, SAND DOLLAR COMMUNITIES

E.S. HOBSON, U.S. Dept. of Interior, Tiburon Marine Lab. , *Belvedere - Tiburon, California* 94920

This study concerns animal communities inhabiting the sandy bottom offshore from California beaches - one of the most widespread, but least studied California inshore marine habitats. The work is centered on aggregations of the sand dollar, Dendraster excentricus, the most prominent macro-organism in this region, and the main feature of a habitat supporting a rich and varied fauna of invertebrates and fishes, including many species important to the surf fisherman.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0534, AVIFAUNAL ECOLOGY OF LIMANTOUR ESTERO

C.J. RALPH, Point Reyes Bird Observatory, *Bolinas, California* 94924

To determine the overall importance of the Upper Limantour Estero, Point Reyes National Seashore, to the avifauna of the Drake's Bay area. Work to be carried out includes assessing the relative importance of habitat types to the different bird species and determining the nature and quantity of food available in the substrate in the estero.

SUPPORTED BY U.S. Dept. of Interior - Natl. Park Serv.

5.0535, EXPERIMENTAL AND BIOMATHEMATICAL ANALYSIS OF THE PHENOMENON OF ATTACK

K.E. WATT, Univ. of California, Graduate School, *Davis, California* 95616

We will continue research on warm freshwater fish predator-prey systems in large thanks and indoor ponds to determine how specific characteristics of the predators, prey and environment interact to determine the efficiency of attack. Many different physiological and ethological parameters are being measured using cinematography. Efficiency of attack will be measured in three ways: l. the number of prey eaten per predator per unit time 2. the biomass of prey eaten per unit biomass of predator per unit time 3. the weight gain of predators per unit time.

A mathematical model is being developed from analytical experiments and computer simulation studies are being conducted to determine if we can mimic the history of populational experiments. Simulation will be conducted on the history of populational experiments. Simulation will be conducted on the computer to determine the factors most important in regulating attack efficiency. Finally, experiments will be performed to check on the findings from the computer sensitivity analyses.

The principal predators used are large-mouth bass and bluegill sunfish, the prey are guppies and minnows.

SUPPORTED BY U.S. National Science Foundation

5.0536, THE DISEASES OF INVERTEBRATE ANIMALS

E.A. STEINHAUS, Univ. of California, Graduate School, *Irvine, California* 92664

Studies are continuing in three principal areas coming within the framework of this project on the diseases of invertebrate animals. Immunological reactions of six widely separated species of marine invertebrates are being investigated using six different species of nonsporeforming bacteria. Some of the animals (for example, the sea hare and the sand dollar) have shown little, if any, bactericidal activity in their normal coelomic fluid. Others, such as the coelomic fluid of sipunculid worms, are lethal to the bacteria. The fluids of some animals, such as that of the sea urchin, fall somewhere in between as far as their natural bacterial inhibiting properties are concerned. Included in the study of the immune properties of these marine invertebrates is an electrophoretic investigation of the bactericidal substances involved.

In another part of the project, ‘tumors‘ produced in the cockroach Leucophaea maderae by using the Scharrer techniques of severing the recurrent nerve, chemical carcinogens, strontium-89, X-irradiation, and decapitation are being intensively studied. Detailed histopathological as well as thorough electron-microscope examinations of the ‘tumors‘ and ‘inflammation‘ are being made. Attempts to confirm certain aspects of the work of the French scientist, Matz, who claims to have found an infectious tumor-inducing material in ‘tumorous‘ locusts have as yet not succeeded. Histopathological studies, as well as studies of the endocrine system of wax-moth larvae (Galleria) treated with carcinogenic chemicals and irradiations, have yielded interesting results, the pathological significance of which has not yet been determined.

An extensive investigation of the teratologies of the beetle Tenebrio molitor is underway. Already discovered are some rather spectacular changes in ultrastructures (mitochondria, glycogen granules, etc.) of the deformed insects, which constitute over 20% of our continuing culture.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0537, PROTEIN SYNTHESIS DURING THE EARLY DEVELOPMENT OF THE SEA URCHIN EMBRYO

H. TIMOURIAN, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551

To develop techniques for the study of the biological and physico- chemical changes in the ribosomes and polysomes during early development in order to determine whether damage by small doses of radiation to the machinery for protein synthesis can be detected in the sea urchin embryo. The first hours of development are ideally suited, for there is no dependence on the genetic material and any effects can be completely divorced from those imposed on the nuclear genome. Biological changes are monitored by the ribosome capacity to participate in protein synthesis; and physico-chemical changes are monitored by density gradient centrifugation and by their capacity to bind metal ions and to be digested by various enzymes.

Changes that take place in eggs at the time of fertilization have been determined in ribosomes and supernatant fractions by comparison of subcellular fractions from fertilized and unfertilized eggs.

SUPPORTED BY U.S. Atomic Energy Commission

5.0538, WHISTLE CONTOURS IN ODONTOCETE CETACEANS

D.K. CALDWELL, Los Angeles Co. Museum, *Los Angeles, California* (N00014-67-C-0358)

The investigators will attempt to prove their hypothesis that individual porpoises of the group they are studying produce an identifiable whistle ‘signature‘ which varies in only certain prescribed directions and which is different for each animal. They will study the information content and the behavioral significance of the whistles, as well as those other vocalizations under a variety of social situations, to determine to what extent the sounds are purposeful, and what degree of importance may be attached to vocalization in comparison with tactile, visual, and other means of communication.

Studies of signalling methods among schooling marine animals can provide valuable ideas for new and improved communication techniques based on evolved biological systems. In addition, acoustic signalling for training purposes must be thoroughly explored if the Navy is to utilize porpoises as aids to divers in such operations as SEALAB, rescue missions, and salvage activities.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0539, THE PORIFERA OF FANNING ISLAND, CENTRAL PACIFIC

G.J. BAKUS, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

The present research will complete a study of the marine sponges of Fanning Island, Line Islands, central Pacific. The major goals of this third year of work are:

1) To complete descriptions and identifications of the numerous species collected.

2) To determine the effectiveness of the East Pacific Barrier in preventing dispersal of sponges from Central America to the Line Islands, and the reciprocal.

3) To evaluate the effects of sedimentation (specifically siltation) on the distribution and survival of certain sponges at Fanning Island.

SUPPORTED BY U.S. National Science Foundation

5.0540, DEEP WATER BENTHIC POLYCHAETES

O. HARTMAN, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

Precise knowledge of benthic life in these depths remains almost unknown, and until a few years ago it was impossible to take, measure and identify the animals inhibiting these areas. A few studies have shown that the organisms differ wholly from those in shallower bottoms. Quantitative studies of oceanographic deep areas became realizable only where ocean floors had been sonically charted, and after adequate instrumentation had been devised. Deep sea photography has shown the abundance of hillocks, depressions, trails and other surface irregularities, believed made by subsurface animals. Submersible vessels and TV cameras have revealed the activity of such forms. Tens of thousands of photographs are available from widely scattered places; many clearly show the surface features presumably made by benthic animals. Unfortunately the organisms constructing these ripples and holes cannot be identified even to major group from surface features alone. The few quantitative biological programs which have been pursued have shown that benthic life is remarkably diverse and abundant, and that it differs from one place to the next, according to depth and other physical features; specific components within a sample are unpredictably diversified.

5. LIVING SYSTEMS (NON-HUMAN)

Analyses of quantitative samples off Southern California have shown the presence of a highly endemic fauna, existing at all depths examined, and varying measurably within narrow depth classes. Based on faunal composition the basins may be grouped according to latitude, proximity to land or open sea, and the animal kinds differ from one basin to the next, and from those in new basin areas.

SUPPORTED BY U.S. National Science Foundation

5.0541, SYSTEMATIC STUDIES OF CERTAIN MARINE PARASITIC WORMS

W.E. MARTIN, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

This investigation has three quite separate aims within the broad field of marine helminth parasitology. First, life histories of species of the taxonomically enigmatic trematode genus Renicola will be studied, and the results should provide a firm base for identifying species within this group.

The second aim concerns a nematode that is a spiruroid but with the habitat of filarioid. Spiruroids are obtained by ingesting infective stages in intermediate hosts, perhaps always arthropods, whereas filarioids are transmitted by the blood sucking activities of such hosts. Spiruroids localize in the verterbrate in places affording an exit for their eggs but the species in question seems to be an exception. The two groups form one order and helminthologists believe that the filarioids evolved from spiruroids in a manner paralleling that which apparently occurred in sporozoan and haemoflagellate protozoans. Hence the life hsitory of the species in question would be of particular interest.

Thirdly, a new acanthocephalan worm from a marine fish will be studied from various approaches. Little is known concerning the life history of these thorny-headed worms.

SUPPORTED BY U.S. National Science Foundation

5.0542, THE SYSTEMATICS AND ZOOGEOGRAPHY OF THE BRYOZOAN FAUNA OF THE HAWAIIAN ISLANDS

J.D. SOULE, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

This investigation is concerned with the taxonomy and zoogeography of the Hawaiian fauna of Entoprocta (Bryozoa). The chief objectives of the study involve extensive collecting in the regions of the mid- Pacific area not previously collected or only poorly represented in existing collections, systematic study of the bryozoan fauna of the mid-Pacific area, correlation of data on the known distribution of tropical bryozoan species with those of the Hawaiian Island species, and the assembling of data relevant to the question of endemism among bryozoans.

SUPPORTED BY U.S. National Science Foundation

5.0543, PROTEIN SYNTHESIS ACTIVATION IN SEA URCHIN EGGS

P.C. DENNY, Univ. of California, Graduate School, *Los Angeles - U.C.L.A., California* 90024

The broad objective of this research is to find out the sequence and kinds of regulatory events which are responsible for the initiation of development in the sea urchin egg. The protein synthesis system contained in these eggs will serve as the basis for the investigation. It is especially advantageous for this purpose because first of all its activity is fairly easy and accurate to measure and secondly its change in activity at fertilization parallels the general changes in the egg. Specifically, the objective is to follow step by step, beginning with sperm penetration, the events which result in the fully active protein synthesis system. On one hand, the response will be investigated at the molecular level, starting with the active system in the fertilized egg and from there determining the nature of the inhibition to the system in the unfertilized egg. On the other, the activation sequence will be investigated at the initial step, sperm penetration, by examining the pattern of activation of the protein synthesis system in the egg and the localization of activity at various intervals shortly after fertilization.

Another objective which now can be realized is the electrophoretic characterization of the proteins which are actually being synthesized in the periods immediately following fertilization or parthenogenetic activation of anucleate fragments. To do this a new approach has been developed which is based upon the in vitro synthesis and release of the proteins by polyribosomes taken from the eggs or fragments. Using this technique, the developmental stage in which a given protein is being synthesized can be easily pinpointed, and any interference in synthesis or characterization by the large amount of endogenous protein present in the egg can be avoided.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0544, CETACEA OF TIERRA DEL FUEGO

K.S. NORRIS, Univ. of California, Graduate School, *Los Angeles — U.C.L.A., California* 90024

Under GA-1420 research plans for use of R/V Hero were approved for conducting a survey of the small cetaceans found in the waters of the Inland Passage, Chile, and in the Straits of Magellan, Chile- Argentina, and off-shore waters of Tierra del Fuego, Argentina-Chile. In reviewing field plans, the principal investigator found need for a number of unanticipated but essential items necessary for the normal development of the field work. Because these will not be provided as standard shipboard supplies, the items, as listed in the supplement budget, will be purchased in the United States for delivery to R/V Hero prior to her departure for South American waters.

International travel will be provided under USARP for five persons (Schevill, McFarland, Harvey, Schallenberg and M. Barrett); Norris, Bloome, and R. Barrett will be in Chile under the exchange program between the University of Chile and the University of California. There is an increase in the shipboard party from six (6) to nine (9) members plus a Chilean scientist. Otherwise, the basic plan of research approved under GA-1420, the shipboard arrangements, time schedules, and embarkation from Puerto Montt, Chile, remain unchanged.

SUPPORTED BY U.S. National Science Foundation

5.0545, STUDIES OF SOUND PRODUCTION

K.S. NORRIS, Univ. of California, Graduate School, *Los Angeles — U.C.L.A., California* 90024

The program is designed to illuminate sound production and projection in the toothed whales, and the use of these signals in discrimination. In addition the structure of emitted signals and signal trains is to be studied. The integration of emitted signals and returned echoes is also to be studied by various means. In totality the object is to learn how porpoises emit and utilize clicks and click trains to determine features of their environment, what the limits of discrimination ability under various circumstances might be, and how sounds are received and transmitted to the inner ear.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0546, ECHO RANGING SIGNALS

T.C. POULTER, Stanford Research Institute, *Menlo Park, California*

The echo ranging signals of seals and sea lions are being studied in captivity and in their natural surroundings. Recording techniques have been developed for tracking animals under ice and laboratory facilities built for behavioral tests of pinniped sonar abilities.

Analyses of pinniped signals has included conversion to visual display allowing identification of some acoustic characteristics of the signals. Further studies will investigate the use of computer technology in fine analysis of these signals.

Maintaining a colony of captive animals for sonar and related experiments has lead to integrated research centered on the health and care of pinnipeds. Fur seal, California sea lion, Steller sea lion, elephant seal and harbor seal pups are being raised in the laboratory setting and insights have been gained into some health problem of infant and adult animals.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0547, PERCEPTUAL, VOCAL, AND ECHO-RANGING BEHAVIOR OF SEALS AND SEA LIONS

R.J. SCHUSTERMAN, Stanford Research Institute, *Menlo Park, California*

The investigator will continue work begun under earlier grants (GB-1437, GB-4349) on the perceptual, vocal, and echo-ranging behavior of seals and sea lions.

Earlier studies have pointed to the need of obtaining further data of a comparative nature concerning the avenues by which seals and sea lions gain information about their environment, and organize their information in a meaningful way for successful adaptation to both a marine and terrestrial existence. The investigator has outlined the following research problems: 1. The measurement of various aspects of aerial and underwater visual acuity under several conditions of illumination. 2. The discrimination and classification of shapes in different spatial orientations. 3. The determination of sound detection thresholds, and the degree to which sound patterns can be discriminated. 4. The types of vocalization, the conditions under which they occur, and the behavioral displays with which they are associated.

SUPPORTED BY U.S. National Science Foundation

5.0548, PHYSIOLOGICAL VARIATION IN SUBTIDAL AND INTERTIDAL MARINE INVERTEBRATES

E. SEGAL, San Fernando Valley State Coll, Graduate School, *Northridge, California* 91326

00NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

5.0549, INFECTIONS IN MARINE MAMMALS USED AS LABORATORY ANIMALS

D.G. JOHNSTON, Saint Johns Hosp. , *Oxnard, California* 93032

The objective of this research is to isolate, and characterize morphologically and biochemically, microorganisms obtained from various tissues of marine mammals. Standard microbiological techniques will be employed initially. When this primary objective is obtained, the response of sea mammals to human pathogens and to the use of antibiotic and chemical therapy will be studied.

The information derived from this study will be valuable in providing care for marine mammals kept in captivity for scientific purposes. Some of the infections of porpoises, for instance, have been attributed to Erysipelothrix insidiosa, Diplococcus pneunomiae, and Pseudomonas aeruginosa. This project is in support of the behavioral studies on porpoises at the U. S. Naval Missile Center, Point Mugu, California. The investigator will remain cognizant of the possibility that microorganisms infectious for marine mammals may also be hazardous to man under certain circumstances as for instance during prolonged periods of deep submergence involving frequent physical contact with ocean water.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0550, BIOCHEMISTRY OF FERTILIZATION AND EARLY DEVELOPMENT

D. EPEL, Stanford University, Graduate School, *Palo Alto - Stanford, California* 94305

Brief Description of Research Project: Based on the premise that the activation of sea urchin eggs upon fertilization can be traced back to a primary biochemical reaction, studies are concentrated upon reactions involving TPNH (NADPH)* His reason for choosing this substance is that the steps in protein synthesis seem to be intact in the unfertilized egg, except perhaps, for the activation of transfer RNA, and DPN kinase activity is increased 5-6 fold after fertilization.

Approaches to biosynthetic activation will concentrate on 1) the role of post-fertilization increases in TPNH in changing rate or pattern of biosynthesis and 2) the role of changes in energy production in regulating biosynthesis. The second phase of the investigation will be a comparative biochemical study of fertilization, using other invertebrate and vertebrate eggs.

SUPPORTED BY U.S. National Science Foundation

5.0551, MARINE WASTE DISPOSAL AND SEA URCHIN ECOLOGY

W.J. NORTH, Calif. Inst. of Technology, Graduate School, *Pasadena, California* 91109

Southern California communities are growing rapidly and depend intimately on the ocean for food, recreation, and waste disposal. At times the varied human activities seriously interfere with each other and with the natural environment. Unless preventive measures can be developed, metropolitan growth will clearly disrupt nearshore ecology to the point where few marine biological resources will survive. Our broadest objective is to alleviate this situation to the greatest extent possible.

The principal area of our concern has been the California kelp beds because their great extent, high productivity, and richness of species and biomass plainly marks them as regions of singular importance. Our overall research program is divided into two sections; one section emphasizes development of techniques for controlling and improving kelp communities while the other concentrates on gathering basic ecological knowledge that provides the background for intelligent control. This proposal is in the second category. Interactions between these two sections are outlined in an addendum enclosed herewith.

One of the chief factors affecting the kelp communities adversely is apparently an imbalance resulting from overgrazing by sea urchins. We suspect that there is a nutritional link between discharged sewage and the dense urchin populations. The proposed investigation should confirm or disprove the existence of the suspected link. If such a relation is verified, future planning of many seaside municipalities will benefit from the information.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0552, CARDIOVASCULAR ADJUSTMENT TO DIVING ASPHYXIA

R. ELSNER, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

This continuing support is for a second year of investigation of cardiovascular adjustment in Antarctic seals to diving asphyxia. The studies are of three types: (1) the determination of natural diving time in female and very young seals; (2) the elucidation of circulatory changes by instrumentation of female seals; and (3) the investigations of properties of seal fetal and maternal blood with particular reference to oxygen transport mechanisms. The first year of work provided familiarity with Antarctic field conditions. It established safe dosage of drugs used in tranquilization and immobilization of experimental animals; and techniques and safe use of surgical anesthesia. It permitted successful implantation of Doppler ultrasonic blood flow transducers using aseptic surgey; and the measurement of free-diving time and depths in seals. In addition, studies were begun on the respiratory properties of blood of Weddell seals. It is proposed to extend these studies during the 1968-69 field season.

The field work will be conducted at McMurdo Station under the direction of the principal investigator, with three assistants from 1 September - mid-November 1968.

Winter flight participation is anticipated.

SUPPORTED BY U.S. National Science Foundation

5.0553, CIRCULATORY REACTIONS TO ASPHYXIA

R.W. ELSNER, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038

Some features of the circulation peculiar to marine mammals are under study. Profound alterations of cardiac output and blood flow distribution have been investigated during experimental underwater diving. These changes are adaptive in nature and lead to effective prolongation of diving time by circulatory redistribution ensuring adequate perfusion of myocardium and brain while other organs are made ischemic by widespread vessel construction. Blood flow often fell to zero in renal, mesenteric, muscle and skin circuits. Cardiac output decreased, while arterial pressure was well maintained. Demonstration of similar, but not usually as profound, responses in terrestrial animas, including man, suggests that the reaction of diving mammals is a special instance of a more general response to asphyxia. On the basis of these findings new studies are being initiated in an attempt to clarify perinatal responses to asphyxia. Preliminary experiments have demonstrated the feasibility of instrumenting fetal sheep in utero and subsequent recording of blood flow in the unanesthetized, unrestrained animal. Such measurements have been obtained from lambs during birth. Blood flow distribution and responses of both fetal and maternal circulations will be systemmatically investigated during birth and induced asphyxia in both sheep and seals. A primary long term goal of these studies will be the understanding of control mechanisms specifically involved in the cardio-vascular responses to asphyxia. Other investigations into special aspects of marine mammal circulation are being continued. These include X-ray angiographic and flowmeter studies of circulation as it relates to temperature regulation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0554, MARINE VERTEBRATES OF THE CALIFORNIA PENINSULA

C.L. HUBBS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The research, on the marine vertebrate fauna of the 'California Peninsula' (Cape San Lucas to Pt. Conception) is to be done in systematics, zoogeography, oceanography, and ecology. Mapping of fish distribution is underway; systematic reviews of fishes are completed, being completed, or are underway. Studies of marine mammals, birds, and reptiles are also in progress, and these are being integrated with oceanographic work, particularly the analysis of inshore sea surface temperatures.

SUPPORTED BY U.S. National Science Foundation

5.0555, DEEP DIVING ANTARCTIC BIRDS AND MAMMALS

G.L. KOOYMAN, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

This is a program in hyperbaric physiology on the deep diving behavior of bird and mammal species using restrained and unrestrained experimental animals. Because seals have tolerance for great hydrostatic pressures, they are valuable experimental subjects in elucidating mechanisms of adaptation to high pressure and rapid pressure changes. Less pressure-tolerant diving birds will be used for comparison. The Weddell seal and emperor penguin are the most suitable animals for the planned field experiments; preliminary testing of equipment and techniques will be made at the University with locally procured harbor seals. Physiological measurements will include heart rate, metabolic rate, total lung capacity, tidal volume, gas volume during the dive, and alveolar gas composition before and after the dive. Instrument packages have been developed and used for the unrestrained study techniques. Two portable high pressure chambers will be constructed at Scripps Institution of Oceanography for use at McMurdo Station.

This program will utilize the winter flight to McMurdo Station for field work, beginning September and completing mid-December 1968. The principal investigator will require scuba qualifications; he will be assisted at the biolab by Dr. Lenfant and one graduate student. Animal Lift required for two Weddell Seals.

SUPPORTED BY U.S. National Science Foundation

5.0556, THE COMPARATIVE IMMUNOLOGY OF LOWER ORGANISMS

J.E. CUSHING, Univ. of California, Graduate School, *Santa Barbara, California* 93018

The research objective of the present proposal is to investigate two areas concerned with the immunology of marine organisms. The first of these is the immune responses of marine invertebrates with the purpose of learning more concerning the background against which the immune mechanisms of higher vertebrates evolved. The second of these is concerned with the blood groups and related substance of marine forms with the view of learning more of the variations and evolutionary relationships of these substances among these forms. These objectives are of growing biological interest as the knowledge of the mechanism of antibody production increases and needs to be related to a general biological background.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0557, CYTOLOGICAL CHARACTERISTIC

T.L. SIMPSON, Univ. of Hartford, Graduate School, *Hartford - West Hartford, Connecticut* 06117

An initial study of marine, clathriid sponges has shown that cytological characteristics when employed as taxonomic criteria allow the development of a natural classification which cannot be arrived at solely by the employment of traditionally-utilized characteristics: the skeletal elements. The object of the present study is twofold. First, additional species of clathriid sponges will be examined cytologically and, where possible, by explanation in order to obtain a more complete picture of the evolution of genera within this group of sponges. Secondly, an intensive study of the functional and developmental physiology of Microciona prolifera will be initiated in order to develop methods whereby the functions and developmental roles of the mesenchymal cell types can be elucidated. If fruitful, this will add a new dimension to the use of cytological features for sponge systematics. Namely, it will make possible comparative studies based not only on cytological characteristics but also on the functional and developmental role of sponge cells.

SUPPORTED BY U.S. National Science Foundation

5.0558, SYSTEMATIC STUDIES OF SPONGES OF THE JAMAICAN FORE-REEF SLOPE

W.D. HARTMAN, Yale University, Peabody Museum of Nat. Hist., *New Haven, Connecticut* 06520

It is proposed to study the systematics of the rich sponge fauna living in the fore-reef slope environment of Jamaica by both classical morphological methods and biochemical techniques. The material available for the study was collected by SCUBA divers at depths ranging from 25 to 80 meters. In the more classical studies emphasis will be placed on revisions of large, difficult genera such as Agelas, Xestospongia and its relatives, and Verongia. Every attempt will be made to refer to original type material in an effort to clarify nomenclatural problems. The collections of such early authors as Duchassaing and Michelotti and Schmidt have already been studied, and it is hoped that Carter's material may be examined in Liverpool.

As a means of obtaining additional characters for a re-examination of sponge relationships at the familial and generic levels, application of a series of biochemical techniques will be undertaken on the keratosan sponges in the first instance, since they lack the sclerites that provide useful characters in other groups of sponges. These studies will include electrophoretic separation of soluble cell proteins and thin layer electrophoresis and chromatography applied to the free amino acid content of the organisms. Exploratory attempts at DNA hybridization experiments will be undertaken using sponge larvae as source material.

SUPPORTED BY U.S. National Science Foundation

5.0559, THE INFLUENCE OF DEPOSIT FEEDING BENTHOS ON THE STABILITY OF BOTTOM SEDIMENTS AND COMMUNITY TROPHIC STRUCTURE

D.C. RHOADS, Yale University, Graduate School, *New Haven, Connecticut* 06520

The spatial separation of deposit and suspension feeding benthos is a major ecologic phenomenon of the marine environment. Existing hypotheses relate the occurrence and relative abundance of these feeding types to food source availability, i.e. deposited or suspended. This hypothesis is inadequate, however, to explain low diversity of suspension feeding benthos on deposit feeder dominated muds in Buzzards Bay, Massachusetts that have an abundant food supply suspended over the bottom. An alternative exclusion mechanism is suggested. Intensive sediment surface reworking activities of deposit feeders produce a granular, uncompacted, high water content interface easily suspended by weak tidal currents. The physical instability of this reworked bottom type is effective in decreasing suspension feeder diversity and biomass by: 1) clogging filtering mechanisms, and 2) resuspending and burying newly settled suspension feeding larvae. Instability of the reworked interface is also limining to sessile epifauna unable to maintain a firm connection with the bottom.

SUPPORTED BY U.S. National Science Foundation

5.0560, THE SPECTRAL SENSITIVITY OF THE GREEN SEA TURTLE (CHELONIA MYDAS)

P.J. OSHEA, Univ. of Delaware, Graduate School, *Newark, Delaware* 19711

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY National Council to Combat Blindness Inc.

5.0561, BENTHIC COMMUNITIES

G. THORSON, Kobenhavns Universitet, *Copenhagen, Denmark* (F61052-67-C-0089)

The investigator is conducting research on the biology of organisms living in, on, and above the bottom level of off-shore waters with particular emphasis on those aspects of metabolism, behavior, and developmental cycles which affect and are affected by the community and environment. He is comparing data from similar localities throughout the world to detect any primary faults in his hypothesis regarding the internal control mechanisms in community relationships. The program includes studies of the microfauna, not only as food organisms of larger forms, but also as larval and other early stages of larger forms. Studies will be continued on the invertebrate predator-prey balance, including the role of parasites.

This research is part of the Oceanic Biology Program which provides the Navy with information concerning the natural activities of biological organisms that influence Naval operations. An understanding of the factors resulting in the formation of certain types of biological communities will permit the prediction of conditions such as fouling, modification of bottom sediments, consolidation or shifting of bottoms, and chemistry of the benthic areas. Since Dr. Thorson's work is based on data received from collaborators throughout the world, as well as hiw own research, predictability is much enhanced.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0562, RENAL SALT EXCRETION IN MARINE BIRDS

D.S. DOUGLAS, George Washington University, Graduate School, *Washington, District of Columbia* 20006

Previous studies have shown that marine birds respond to salt loads with unexpected reductions in urinary salt excretion. This proposal requests support for study of three questions related to this finding: (1) What is the cause of the decreased salt concentration in the urine of marine birds which have received salt loads? (2) What is the cause of the decreased rate of urine flow in salt-loaded birds? (3) Are there habitat-related differences in the way the kidneys of different species of marine birds respond to salt loads.

In order to obtain answers to these questions, measurements of renal function (including glomerular filtration rate, osmolar clearance, tubular sodium transport, and tubular water reabsorption) will be made upon three species of gulls. The estuarine herring gull will be the principal bird studied since it is relatively large and more readily obtained than other gulls of comparable size. The ring- billed gull and the kittiwake will be used to provide a comparison between freshwater, estuarine, and pelagic species of gulls.

SUPPORTED BY U.S. National Science Foundation

5.0563, FORAMINIFERA FROM HEDLEY HARBOR, MASSACHUSETTS

M.A. BUZAS, Smithsonian Institution, *Washington, District of Columbia* 20560

The distribution and abundance of benthonic foraminifera in Hadley Harbor is being studied from two sampling times and an attempt to correlate measured environmental variables with faunal distribution is being made.

SUPPORTED BY Smithsonian Institution

5.0564, PATTERNS OF SPECIES DIVERSITY - TERTIARY-RECENT

M.A. BUZAS, Smithsonian Institution, *Washington, District of Columbia* 20560

The relative abundance and number of species of Foraminifera in Bay's, nearshore open ocean and offshore open ocean are being examined from Greenland to the Gulf of Mexico by means of the information function. Several Tertiary sections of the east coast are also being studied to examine the relationship between the recent pattern and patterns in the past.

SUPPORTED BY Smithsonian Institution

5.0565, POPULATION DYNAMICS OF FREE-LIVING MARINE NEMATODES INHABITING THE BENTHOS OF HADLEY HARBOR COMPLEX, WOODS HOLE, MASS.

W.D. HOPE, Smithsonian Institution, *Washington, District of Columbia* 20560

There is no detailed information available on the seasonal changes in the population structure and population density of free-living marine nematodes during an annual cycle in a given habitat. Such information will contribute to a better understanding of the ecological relationships of nematodes.

Specifically, this study was undertaken to determine the following: 1.) What changes, if any, occur in the numbers of individuals for each species of marine nematode inhabiting the sediment at two stations in Hadley Harbor during one annual cycle. 2.) How often and how long each species breeds. 3.) The time required for maturation of juveniles. 4.) Mortality rate for at least the dominant species. 5.) Whether or not there are correlations between changes in the populations of nematodes and changes in the physical and chemical parameters of the environment. 6.) Gut contents of macro-invertebrates from these stations will be examined to determine what organisms may be preying on nematodes.

SUPPORTED BY Smithsonian Institution

5.0566, MARINE NEMATODES OF THE CAPE COD AREA

W.D. HOPE, Smithsonian Institution, *Washington, District of Columbia* 20560

Marine nematodes of the Cape Cod Area are virtually unknown except for a few species described, but not illustrated, by Cobb (1933). Research on this group of animals in the Cape Cod area has been prohibitive because of taxonomic difficulties. Yet, they are a very important, if not the most important, constituent of the meiofauna.

For this reason, a survey of the marine nematodes of the Cape Cod Area was conducted during the winter and summer of 1965 which will lead to a series of publications describing and illustrating specimens that were collected. It is intended that keys and habitat data will also be included.

The specimens are presently being sorted and mounted for study and all type specimens of marine nematodes originally collected on mid and Northern shores of the East Coast of the United States have been gathered at the Museum of Natural History for comparative studies.

SUPPORTED BY Smithsonian Institution

5.0567, COMPARATIVE MORPHOLOGY OF MARINE NEMATODES

W.D. HOPE, Smithsonian Institution, *Washington, District of Columbia* 20560

Detailed anatomical studies of marine nematodes are limited to very few reports in which histological techniques for light microscopy have been employed and almost no information is available from electronmicroscope studies.

Histological studies of selected marine nematodes will be conducted to obtain more detailed information on the relationships of marine nematodes and functions of their various organs. Studies have been initiated on Deontostoma californicum Steiner and Albin, 1933 with particular emphasis on the nervous system, and during FY 1968 I will spend six months at Toronto University, collaborating with Dr. Wright on a comparative study of the musculature of nematodes.

SUPPORTED BY Smithsonian Institution

5.0568, PACIFIC OCEAN BIOLOGICAL SURVEY PROGRAM

P.S. HUMPHREY, Smithsonian Institution, *Washington, District of Columbia* 20560

This program is a biological survey of the central Pacific islands, concentrating mostly on seabirds. Emphasis is on the pelagic distribution of birds in relation to oceanographic and meteorological factors.

SUPPORTED BY Smithsonian Institution

5.0569, THE TAXONOMY AND ZOOGEOGRAPHY OF THE POLYCHAETOUS ANNELIDS OF THE GULF OF MEXICO AND THE CARIBBEAN SEA

M.L. JONES, Smithsonian Institution, *Washington, District of Columbia* 20560

The basic purpose of this project is to make a study of the polychaetous annelids of the Gulf of Mexico and the Caribbean Sea. Though widely distributed throughout this area and rather easily collected, it remains that the polychaetes of the Gulf and Caribbean are rather poorly known, and it is hoped that the present collections (approximately 450 localities from 17 general locations), as well as future collections, will, when processed, shed more light on this relatively neglected group.

Present collections come from or near Veracruz and Tuxpam, Mexico; Port Arkansas, Texas; St. Andrew Bay, offshore at Panama City, Alligator Harbor, Apalachicola Bay, Cedar Key, Tampa Bay, Cape Haze, Naples, Tavernier Key, Key West, and Biscayne Bay, Florida/ Bimini and Andros, Bahamas; Jamaica and Barbados, West Indies; Puerto Rico; and Margarita Island, Venezuela. In the future, further collections will be made along the Antillean chain, through the Bahamas, and along the Central and South American coasts.

Ultimately, comparisons will be made with the polychaete fauna of adjacent areas and those of other tropical and subtropical regions.

SUPPORTED BY Smithsonian Institution

5.0570, THE TAXONOMY AND ZOOGEOGRAPHY OF THE MAGELONIDAE OF THE WORLD

M.L. JONES, Smithsonian Institution, *Washington, District of Columbia* 20560

The family Magelonidae (Polychaeta: Annelida) has been known for somewhat over 100 years. In this period of time, 26 species have been described, all of which have been assigned to Magelona, the only genus of the family.

Recent collections from Texas, Puerto Rico, and offshore from Georgia, suggest that there is reason for the erection of at least two new genera. Collections from Santa Catarina Island, Brasil, the type locality of the type species of the genus Magelona, have provided material of M. papillicornis, the original species of the genus; redescription of this species will necessitate the renaming of certain European magelonids which have been erroneously referred to M. papillicornis, and the ressurection of a former synonym of Magelona.

On the basis of loans from the museums of the world and material presently in the collections of a number of marine laboratories of the world, it is intended that the family be monographed, both from a taxonomic, as well as a zoogeographic standpoint.

SUPPORTED BY Smithsonian Institution

5.0571, ECOLOGY OF ECHINOIDS

P.M. KIER, Smithsonian Institution, *Washington, District of Columbia* 20560

Study of the living habits of echinoids in particular relative to the bottom substrate.

SUPPORTED BY Smithsonian Institution

5.0572, A SYSTEMATIC REVISION OF THE HOLOTHURIAN FAMILY PSOLIDAE - ECHINODERMATA - HOLOTHUROIDEA

D.L. PAWSON, Smithsonian Institution, *Washington, District of Columbia* 20560

At present, 77 nominal species are known in this family of sedentary holothurians. Six genera are known, and the group is being revised genus by genus. Revision of two genera is now complete. Some species share important anatomical features with certain groups of Paleozoic echinoderms, and an attempt will be made to interpret the anatomy of the psolide in the light of the fossil record.

SUPPORTED BY Smithsonian Institution

5.0573, DISTRIBUTION MAPS OF ANTARCTIC HOLOTHURIANS AND ECHINOIDS - ECHINODERMAT

D.L. PAWSON, Smithsonian Institution, *Washington, District of Columbia* 20560

Under the aegis of the American Geographical Society, charts showing the distribution about the Antarctic and Subantarctic regions of echinoids and holothurians have been prepared. Approximately 80 species of holothurians and 50 species of echinoids are known from the area. Some attempt has been made to explain the patterns of distribution in relation to physical factors of the environment.

SUPPORTED BY Smithsonian Institution

5.0574, MARINE POLYCHAETE WORMS OF THE NEW ENGLAND REGION (GULF OF ST. LAWRENCE TO CHESAPEAKE BAY)

M.H. PETTIBONE, Smithsonian Institution, *Washington, District of Columbia* 20560

The polychaete worms of the New England region (or Gulf of St. Lawrence to Chesapeake Bay) are being worked up by Families, including synopses of the Families, Keys to the Families, Genera and Species. Included for each species are brief description, figures, notes on its biology, known geographic and bathymetric distribution, and selected synonymies and references. The first half of the study has been completed. Work continues on completion of the project. New species and revisions are worked up separately.

SUPPORTED BY Smithsonian Institution

5.0575, MARINE POLYCHAETE WORMS OFF THE COLUMBIA RIVER, OREGON

M.H. PETTIBONE, Smithsonian Institution, *Washington, District of Columbia* 20560

A collection of polychaetes, obtained by deep-water trawling operations off the mouth of the Columbia River, Oregon, during cruises carried out by the Bureau of Commercial Fisheries, aboard M/V Commando and M/V John N. Cobb, 1961 to 1964, is in process of being worked up. Included in the study are the following: a. A new genus of species of Aprhoditidae, including a review of the genera of the family (completed). b. A new genus and species of bathypelagic Polynoidae, including a review of some related genera (completed). c. A study of a species of Polynoidae commensal with three species of sea stars.

SUPPORTED BY Smithsonian Institution

5.0576, CANADIAN ARCTIC AND SUBARCTIC POLYCHAETES COLLECTED BY E. H. GRAINGER

M.H. PETTIBONE, Smithsonian Institution, *Washington, District of Columbia* 20560

A large collection of polychaetes, obtained by E. H. Grainger on the Calanus Expeditions during 1953 to 1964, serve as a basis for a study on the Canadian Arctic and subarctic polychaetes. The collection has been separated to families. The species are being worked up by families.

SUPPORTED BY Smithsonian Institution

5.0577, THE BIOLOGY OF ROCK-BORING SIPUNCULIDS

M.E. RICE, Smithsonian Institution, *Washington, District of Columbia* 20560

Species of Phascolosoma, Aspidosiphon, Lithacrosiphon, and Cloeosiphon are commonly found associated with coral reefs where they are known to burrow into coral rock and beachrock. Preliminary observations have been carried out on the coral reefs of the Maldives and it is hoped that these studies can be continued with the sipunculids of the Caribbean. The object of the study will be twofold: to determine whether the boring habit is associated with nutrition and to investigate the mechanism of boring. It is planned to begin work in the Caribbean in the spring of 1967.

In the study of nutrition, analyses would be made and compared of gut contents, fecal pellets, and the rock inhabited by the animal. Dr. Karl M. Wilbur of Duke University has tentatively agreed to cooperate in some of the chemical analyses.

An investigation of the boring mechanism would include observations on the behavior of living animals in the laboratory, an examination of the burrows, and a histophysiological study of the skin papillae in an attempt to determine the nature of their secretion.

SUPPORTED BY Smithsonian Institution

5.0578, SYSTEMATICS OF ANTARCTIC SIPUNCULIDS AND ECHIURIDS COLLECTED BY THE ELTANIN EXPEDITION

M.E. RICE, Smithsonian Institution, *Washington, District of Columbia* 20560

This project involves a study of the systematics of the sipunculids and echiurids collected in the Antarctic by the Eltanin Expedition.. Over 500 specimens have been received thus far and more are expected. The specimens were dredged from 300 to 5400 meters and many are from areas in which no previous collections have been made. The specific identification of the specimens is at present in progress; any new species will be described.

SUPPORTED BY Smithsonian Institution

5.0579, REPRODUCTIVE BIOLOGY, DEVELOPMENT, AND SYSTEMATICS OF THE SIPUNCULIDS OF THE CARIBBEAN

M.E. RICE, Smithsonian Institution, *Washington, District of Columbia* 20560

A comparative study of the development of several species of tropical sipunculids belonging to the genera Lithacrosiphon, Aspidosiphon, Phascolosoma, Sipunculus, and Siphonosoma will be started in the spring of 1967. Such information, not now available, is important both to an understanding of the phylogenetic relationships of the phylum, and to an insight into the zoogeographical distribution of these species.

Data will be accumulated on spawning and breeding seasons and on embryogenesis, organogenesis, larval morphology and behavior. This study will involve observations on living animals and embryos in field laboratories and, in addition, histological work, including the technique of embedding in epoxy resins and sectioning at 1 micron on a Porter-Blum ultramicrotome.

One of the considerations will be to relate the findings to those of Dr. Scheltema (WHOI) who, having collected sipunculid larvae of unknown species in great numbers in the North Atlantic Ocean, has proposed that they may be transported by currents from the Caribbean to the Azores and the West Coast of Africa.

Since the Caribbean sipunculids are not well known, the study will of necessity include an investigation of the systematics of the sipunculids of this area. Dr. F. M. Bayer and Dr. G. Voss (University of Miami), currently engaged in a faunal survey of the Caribbean, are interested in this aspect of the study and will make available to me their collection of sipunculids.

SUPPORTED BY Smithsonian Institution

5.0580, SYNECOLOGY OF CARIBBEAN SPONGES

K. RUTZLER, Smithsonian Institution, *Washington, District of Columbia* 20560

Studies are to be made on the interspecific relationships among sponges, competition for space, microanatomical and biochemical aspects of overgrowth, interspecific relationships between sponges and other organisms, and the biological and biochemical problems involved with symbiotic algae and epizoans.

SUPPORTED BY Smithsonian Institution

5.0581, COOPERATIVE SYSTEMATICS STUDIES IN ANTARCTIC BIOLOGY

I.E. WALLEN, Smithsonian Institution, *Washington, District of Columbia* 20560

The Smithsonian Oceanographic Sorting Center will continue the cooperative systematic program begun under GA-261 for the study, determination, and description of Antarctic Biological materials and particularly neglected marine invertebrate groups accruing from past and current United States Antarctic Research Programs. Non -staff, qualified taxonomists of unique competence will be considered for the analyses of biological specimens appropriate to their specialties. The SOSC will make available all essential laboratory and library facilities; the proposal provides for stipends, travel expenses and necessary items of specialized equipment. In all instances, a completed and acceptable manuscript will terminate the successful cooperative systematic study.

With the exception of Heron (S.I), all cooperating systematists will be provided with laboratory quarters, equipment and library facilities at their resident institutions, i.e., Bayer - University of Miami; Mather - University of Queensland; Newman - University of California, San Diego; Pawson - Victoria University; Clark - Dominion Museum; Marumo - Texas A&M.

SUPPORTED BY U.S. National Science Foundation

5.0582, SYSTEMATICS AND ECOLOGY OF MARINE BIRDS

G.E. WATSON, Smithsonian Institution, *Washington, District of Columbia* 20560

Various minor projects are underway to provide data on the systematics, ecology and distribution of seabirds. These include ecological studies of the rare Audouin's Gull in the Mediterranean, distribution of seabirds in the tropical Atlantic Ocean, and the systematics of Antarctic and Indian Ocean birds. Some of the results of this research will be fed into other existing projects and others to be developed. Under this category is also included preparation of the section of Sylviinae for Peters' Checklist of Birds of the World and the genus Alectoris for the Handbook of North American birds.

SUPPORTED BY Smithsonian Institution

5.0583, MOVEMENTS OF SEABIRDS IN THE HUMBOLDT CURRENT

G.E. WATSON, Smithsonian Institution, *Washington, District of Columbia* 20560

Little is known about the movements and abundance of marine guano birds in the Humboldt Current off Western South America. Through the use of micro-transmitters it will be possible to track the daily movements of individual birds on automatic receiving equipment placed on coastal mountains. Color marking large numbers of birds will review populations movements. The combined radio telemetric and observational approaches should yield much new data on both diurnal and seasonal movements of this commercially important bird.

SUPPORTED BY Smithsonian Institution

5.0584, FIELD STUDY - CAPE COD, MASS.

R.A. WALLER, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Washington, District of Columbia*

Obtain information on the distribution, reproduction, and early development of sedentary and sessile marine animals in relation to bottom temperature, sediments, and other environmental factors. The study area is off Cape Cod (Highland) Light on the outer coast of Cape Cod, Massachusetts. The observations are made along a line extending from shallow to deep water. Self contained temperature and temperature- pressure recorders are mounted in the mooring blocks of five large navigation-type buoys specially stationed by the Coast Guard at 5 different depths along this line.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0585, ANTIGEN DISTRIBUTION OF DEVELOPING SEA URCHIN EMBRYOS

J.W. BROOKBANK, Univ. of Florida, Graduate School, *Gainesville, Florida* 32601

The uptake of radio-phosphate by isolated ento-mesoderm and ectoderm of developing echinoid embryos is proposed, along with a serological analysis of the tissue associated antigens of these germ layers.

In addition, the time of appearance of paternal antigens in hybrid sea urchins (Lytechinus X Tripneustes) will be investigated during the early development of this cross. Subcellular fractions (various RNA's) will also be studied should the information on appearance of protein antigens warrant this investigation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0586, THE ECOLOGY, MIGRATIONS AND BEHAVIOR OF MARINE TURTLES

A.F. CARR, Univ. of Florida, Graduate School, *Gainesville, Florida* 32601

Description of the Research Project: The research has involved a group of related projects, all aimed at filling gaps in the life cycles of the five genera of marine turtles. A long-term tagging project has been under way continuously at Tortuguero, Costa Rica, since NSF-sponsored studies proved in 1955 that Chelonia is a migratory animal. Data accumulating there has allowed the increasingly refined delineation of the area served by the Tortuguero nesting grounds of Chelonia, and has shed light on changes in population size; on remigration and renesting cycles, on nesting-site tenacity, on the significance of clumped emergence on the nesting beach, and on the question of separate versus aggregated travel between nesting and feeding grounds. A detailed study of the latter was begun during the 1968 grant season and will be continued for three years. Grant personnel has carried out or collaborated in other projects which, together with the Tortuguero program, have tagged about eight thousand turtles in various parts of the world. Tag returns from these should continue to advance knowledge of the natural history of sea turtles for years to come. When the Ascension Island tagging project proved Chelonia to have an extraordinary capacity for open-ocean navigation the Office of Naval Research began furnishing support for tracking experiments to plot migratory courses as a basis from which to investigate navigation cues and senses. Facilities and personnel provided by NSF have been jointly involved in some of this work, and during the 1968 season successful tracking of female turtles in migration was carried out by both optical and radio tracking devices.

Field reconnaissance of nesting and feeding ranges of all the sea turtles has revealed that all the marine turtles are to some degree migratory, and is piecing out the still imperfectly known ecologic geography of the group. A continuing series of field studies of the comparative behavioral ecology of the genera and species is in progress.

SUPPORTED BY U.S. National Science Foundation

5.0587, COMMUNICATIONS STUDIES ON TURSIOPS TRUNCATUS AND OTHER DELPHINIDS

J.C. LILLY, Communication Research Inst. , *Miami - Coconut Grove, Florida* 33133

Objective: This research is a segment of a continuing program of the vocalization and vocalization capabilities of the bottle nosed dolphin Tursiops truncatus. A study of the physical properties of their emissions is in progress. It is the intention of this study to explore the formal structure of vocal exchanges between two animals connected only by an acoustic path. These exchanges will be recorded on separate channels of high speed magnetic tape which will then be fed into computers for auto-and cross-correlational analyses. It is expected that this and other studies on the communications between simpler forms of life will contribute much to our basic understanding of transfer and interpretation of information. Detailed analyses are being made of the communicative abilities of the dolphin. The understanding of the communication capabilities of a species other than man and one having such a large and complex brain as the dolphin is of great theoretical value for understanding human communication and forms a basis for relating such studies to brain structure and function.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0588, PHYSIOLOGICAL STUDIES IN THE BOTTLENOSE DOLPHIN TURSIOPS TRUNCATUS

E.L. NAGEL, Communication Research Inst. , *Miami - Coconut Grove, Florida* 33133

The Cetacea which include the great whales, dolphins, and porpoises, are highly specialized aquatic mammals which show many adaptations and specializations for life in the sea, including the ability to dive deeply and submerge for prolonged periods. The investigations in these animals have been and are concerned primarily with three major organ systems: central nervous, cardiovascular, and pulmonary. On the basis of the principal investigator's studies, to date, it appears that the dolphin's ability to adapt to the aquatic environment and function therein depends in large part on hemodynamic and cardiopulmonary specializations and the special functional relationship these systems establish with the brain via the rete mirabile system. For this reason, these system complexes and their relationships have received emphasis in their studies and in these proposed investigations.

SUPPORTED BY U.S. National Science Foundation

5.0589, GENERAL SYSTEMATIC STUDIES OF THE OCTOCORALLIA OF THE TROPICAL ATLANTIC

F.M. BAYER, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

The proposed research deals with the systematics of tropical Atlantic octocorals. These coelenterates are one of the most important groups of sessile animals in the reef habitat and in many bottom communities of deeper water. Knowledge of the systematics of the West Indian forms has been put seriously out of date by rich collections obtained in the past five years by dredging, trawling and SCUBA diving, and the East Atlantic tropical fauna is very incompletely known. Material from the Straits of Florida, Bahamas, West Indies, Gulf of Mexico, Caribbean Sea, Brazil, and the Gulf of Guinea, now numbering about 900 lots and steadily increasing, will be studied systematically, described, and illustrated, toward two final goals: (1) a revision of the Octocorallia of the continental shelf and slopes of the tropical West Atlantic, and (2) a general account of the octocorals of tropical West Africa. These will include zoogeographical studies to reveal the degree and nature of the faunal relationship of the eastern and western Atlantic; information on geographical and ecological variation of individual species; and studies of the anatomy and histology of as many species as possible, in order to clarify basic questions of classification of higher taxa. The studies now undertaken are the first step toward a thorough modernization of the systematics of the Octocorallia in general, and are preliminary to the investigations of the more complicated (and taxonomically confused) Indo-Pacific fauna. In the two-year period of the present grant, research will be concentrated upon the West Atlantic fauna, and it is anticipated that approximately one-half of the revision of that area can be completed.

SUPPORTED BY U.S. National Science Foundation

5.0590, FERTILIZATION MECHANISMS AND GAMETE PHYSIOLOGY IN MARINE INVERTEBRATES

C.B. METZ, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

Mechanisms involved in the initial events of fertilization including the sperm acrosome reaction, penetration of egg membranes, attachment of the sperm to the egg, membrane fusion and activation of the egg are under investigation. Specifically, the following areas are under attack: 1) Dr. Hinsch is continuing her studies on Libinia with special attention given to ultrastructural aspects of egg and sperm morphology, sperm-egg interaction in naturally spawned eggs, some aspects of oogenesis and spermatogenesis and the nature of the 'skeletal fibers' in the arms of the spermatozoan; 2) a study on sperm and egg antigens in sea urchin fertilization; 3) a completion of the rabbit seminal particle study including the ultrastructure of the male accessory glands and the origin of the seminal particles. The uncapacitated, capacitated and decapacitated rabbit sperms will be compared immunologically. 4) Studies on the relation of non-nuclear (mitochondrial) RNA to DNA and protein synthesis in sea urchin eggs will continue. And, finally 5) an investigation of sea urchin egg antigens, particularly those released at fertilization, will be carried out.

SUPPORTED BY U.S. National Science Foundation

5.0591, UTILIZATION OF ENVIRONMENTAL NUTRITIONAL RESOURCES BY STARFISH

J.C. FERGUSON, Florida Presbyterian College, Undergraduate School, *Saint Petersburg, Florida* 33733

This is a continuation of GB-4994 in which it was shown that epidermal cells could take up free amino acids and glucose from dilute solutions in sea water. The investigator is now determining whether the epidermal cells can also take up dissolved proteins and suspended microorganisms. The importance of such nutritional sources is being evaluated. Special water-pumping responses have been noticed in the presence of dissolved materials. There will be further studies in relation to the concentration and kinds of materials that will stimulate pumping. The studies will be comparative for several species.

SUPPORTED BY U.S. National Science Foundation

5.0592, ENVIRONMENTAL SIGNIFICANCE OF SABELLARIID REEFS

W.F. TANNER, Florida State University, Graduate School, *Tallahassee, Florida* 32306

A study of the influence of worm (Sabellariid) reefs on coastal morphology, erosion and sedimentation. Unlike corals (which require warm, clear, shallow, turbulent marine water), and vermetid (gastropod) reefs (which develop in warm, clear, shallow, quiet marine water), the sabellariids thrive in warm-to-cool, shallow turbulent marine waters in which an appreciable load of clastic sediment (sand, silt) is in transit. The sabellariids have a profound influence on lithification of beach materials (to make beach-rock), and hence on rates and processes of erosion and deposition. They incorporate sand-sized particles in their tube walls, and thus deplete the supply of sand in transit toward localities farther along the beach. Charts and formulae which were based on physical principles only, relating wave parameters to coastal erosion and sediment transport, must now be revised for use in areas where Sabellariids make reefs.

SUPPORTED BY U.S. National Science Foundation

5.0593, MARINE ZOOGEOGRAPHY

J.C. BRIGGS, Univ. of South Florida, Graduate School, *Tampa, Florida* 33620

In September, 1962, work was begun on a study of the general distribution of marine fishes. The coverage was then broadened to cover other groups of marine animals and the manuscript entitled MARINE ZOOGEOGRAPHY. As the result of this enlargement of the original task, about two more years will be required for its completion. Eight chapters out of a projected total of twelve are now ready. Preliminary work of this nature has been done and, during the past three years, a total of twelve smaller pepers was published. Several of the latter are of zoogeographic importance. National Science Foundation support has now been received for the final two years of the project.

SUPPORTED BY U.S. National Science Foundation

5.0594, DEVELOPMENT IN ILYANASSA

A.C. CLEMENT, Emory University, Graduate School, *Atlanta, Georgia* 30322

The program deals with the regulation of early embryonic differentiation in the marine snail Ilyanassa obsoleta (Nassarius obsoletus). Interest centers around the polar lobe, an accessible cytoplasmic protrusion at the vegetal pole which has an important determining influence upon cell values and the general course of differentiation. Techniques to be employed include microsurgery, metabolic inhibitors, centrifugal force, and other appropriate procedures. The cytoplasmic basis of the polar lobe influence, as well as its mode of operation, is the problem of greatest interest.

SUPPORTED BY U.S. National Science Foundation

5.0595, SENSORY PROCESSES

G. VONBEKESY, Univ. of Hawaii, Laboratory of Sensory Sciences, *Honolulu, Hawaii* 96822

The laboratory's broad interest is in the sense organs and transmission pathways of man and other animals, particularly the marine animals. Different sense modalities will be studied and compared for common general sensory principles as well as for principles specific to particular senses.

Initial investigations will study the amplifying mechanism in sensory transducers, the role of inhibition in localization and sensory magnitude, inhibition between point sources in the eye, nerve membrane permeability, the role of free radicals in nerve impulse conduction and sensory changes with neurological disease. A variety of experimental techniques will be employed, such as electrophysiological recording, electron spin resonance, psychophysical 'average error' matching and psychophysical localization.

The support requested for these initial investigations should provide the base for a continued program in each of these areas. It is hoped that the different approaches employed in the same laboratory will not only provide a broad analysis of sensory functioning but will also result in new interdisciplinary questions not easily conceived in 'single-discipline' laboratories. It is further hoped that the geographic location of Hawaii will attract investigators from various parts of the world, and the Pacific Basin area in particular, to mix their ideas and techniques in the same laboratory.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0596, BEHAVIORAL STUDIES OF CETACEANS

K.S. NORRIS, Oceanic Foundation, *Oahu, Hawaii* (N00014-66-C0339)

The principal investigator is studying the behavior of free swimming cetaceans with current emphasis on the Kiko porpoise, Stenella attenuata, and the Pacific pilot whale, Globicephela scammoni. The open-sea data will be obtained through the use of the unique Mobile Observation Chamber, a partially submerged 15-foot observation vessel designed and field tested by the principal investigator under this contract. Preliminary tests indicate that the animals are undisturbed by the 'insinuation' of the Chamber into their midsts, and the investigator is comparing reactions of wild and trained porpoises to a variety of stimuli. He will now attempt to determine the effect on the behavior of the wild population of a trained porpoise added to their school. The causes of schooling and school break up will also be studied.

Underwater communication by cetaceans has important Naval applications. Certain whales have been found by the investigator to possess echolocation capabilities of remarkable precision. The limits of this ability, the conditions under which it operates best, and in fact, the underlying mechanism remains undefined.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0597, AGING IN HYDROIDS

E.E. PALINCSAR, Loyola University, Graduate School, *Chicago, Illinois* 60611 (NONR)

The investigator is studying cell development, particularly senescence and death and the physical and chemical changes that take place in the cell which result in or accompany aging. The animal under study, Campanularia flexuosa, is a colonial coelenterate, a group which includes the most long-lived animals known. To determine what factors initiate the aging process, the investigator is altering experimentally various internal and external environmental parameters and is making comparisons with other forms. He will also compare senescence and death of cells and tissues with that of entire organisms.

Effective attempts to eliminate or control biological pests that interfere with Naval operations by fouling and deterioration of equipment must be based on a thorough knowledge of the biology of the organisms involved. The determination of the death processes of these forms will provide clues to likely methods of attack for such pests. The information is also relevant to the development of cells of higher animals and will contribute to advances in medical science as well.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0598, STATOLITH DIFFERENTIATION IN AURELIA (JELLYFISH)

D.B. SPANGENBERG, Indiana University, Graduate School, *Bloomington, Indiana* 47405

To obtain valuable information concerning mechanisms that regulate cellular differentiation and factors which may alter normal differentiation of cells using the newly developed test system of metamorphosing Aurelia for investigation.

To relate wherever possible the data obtained from these studies to problems of cellular differentiation in growth systems of higher animals, including man and through this application, to provide new approaches, and new information which will be useful in understanding normal cellular differentiation and which will be of value in preventing atypical cellular differentiation in higher animals.

To use the differentiation of statocysts in Aurelia during metamorphosis as a model differentiation system to determine mechanisms by which differentiating or differentiated cells concentrate calcium during development.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0599, INITIATION OF METAMORPHOSIS IN AURELIA

D.B. SPANGENBERG, Indiana University, Graduate School, *Bloomington, Indiana* 47405

Research is in progress to determine the primary factors which are involved in the initiation of metamorphosis in Aurelia. Environmental factors being studied are the effects of low temperature preconditioning and light on this process. Chemical factors also under investigation are iodine and iodinated hormones. Additional research is planned to determine whether neurosecretory materials are involved in the initiation of strobilation. The results of these studies could lead to an understanding of the basic mechanisms involved in the initiation of new growth as polyps undergo extensive mitotic activity and cellular differentiation during metamorphosis. An understanding of such mechanisms in this simple organism could be important in understanding similar mechanisms which may control the initiation of new growth (often abnormal) in higher organisms.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0600, REPRODUCTION AND EMBRYONIC SURVIVAL IN ASCIDIA NIGRA (SAVIGNY)

I.M. GOODBODY, Univ. of The West Indies, *Kingston, Jamaica*

Previous studies on Ascidia nigra have illustrated the pattern of growth and survival in natural populations of adults and juveniles, and have shown that larvae are settling throughout the year in the tropical environment of Jamaica. The intensity of larval settlement varies at different seasons of the year and it is not clear whether this is due to differences in the intensity of spawning or is due to differences in the pattern of embryonic and larval survival.

The present program aims to study the patterns of spawning throughout the year in laboratory reared populations of ascidians and also to study the seasonal pattern of embryonic survival in laboratory reared cultures. Weekly samples of eggs are fertilized and reared under constant conditions of temperature and in sea water from three different marine environments. A. nigra occurs naturally in two of these environments but not in the third. It is anticipated that it may be possible to show whether the absence of the ascidian from the latter may be related to poor survival of embryos in these conditions.

SUPPORTED BY U.S. National Science Foundation

5.0601, GROWTH, DIFFERENTIATION AND NERVE TRANSMISSION IN THE HYDROID, CAMPANULARIA

C.R. WYTTENBACH, Univ. of Kansas, Graduate School, *Lawrence, Kansas* 66045

BRIEF DESCRIPTION OF RESEARCH PROJECT: Studies of four related aspects of terminal elongation and differentiation in Campanularia colonies, a marine hydroid which exhibits a branching pattern, are continuing. Preliminary microscopic observations of living material indicate that stolon and pedicel elongation occurs in a cyclic manner, with alternating forward and backward surges (rather than in a uniform fashion) and that, associated with this, the epidermal cells at these growing tips undergo repeated, extensive changes in shape. The dynamics of this cyclic growth and the motive force behind it are being studied by determining the genetic and environmental effects on its pattern, as well as that of particular drugs. Phase and electron microscopy are being used to interpret the extensive structural changes which occur in the tip epidermal cells throughout the cycle. There is evidence that at or near these elongating tips there may be a zone in which cell destruction occurs. Tissue culture techniques are being used to study the time course of cellular differentiation during hydranth development by determining the developmental potencies of aggregates formed from completely disaggregated immature hydranths of successive developmental stages. Serotonin distribution will be followed in the hope of gaining insight into the nature and origin of neural coordination in these primitive forms.

SUPPORTED BY U.S. National Science Foundation

5.0602, CORRELATION BETWEEN ELECTRICAL PATTERNS AND MORPHOGENETIC PATTERNS DURING REGENERATION

S.M. ROSE, Tulane University of Louisiana, School of Medicine, *New Orleans, Louisiana* 70118

Isolated pieces of stem of the marine hydroid, Tubularia, can transform to hydranths. Pieces too short to form a whole hydranth can often form an anterior portion. The genral rule is that all regions form the most anterior structures not forming anterior to them. The agents of control seem to be regionally specific repressors which move in a polarized field.

It has long been known that imposed electric fields can change the polarity of regenerating hydroids and worms. These two lines of approach to the problem, the electrical approach and the chemical, seem to be coming together. The natural repressors have been found to be positively charged in the pH range of 8.0 to 8.6 and move like histones.

The question under investigation is whether polarized control of differentiation results from the spread of regionally specific repressors in the bioelectric field. The control by repressors in applied fields has recently been demonstrated. Investigations are now directed to learn whether the various methods known to change morphogenetic polarity, including the induction of secondary structures, also change the bioelectric patterns.

SUPPORTED BY U.S. National Science Foundation

5.0603, POLYCHAETES AND ECHINODERMS IN THE LABRADOR SEA

D. DEAN, Univ. of Maine, Graduate School, *Orono, Maine* 04473

The initial scientific cruise of the research vessel Hero in northern Atlantic waters is proposed by the University of Maine as an opportunity to sample the poorly known benthic fauna of the region and to test certain biological concepts concerning the modes of reproduction of selected organisms. The particular interest of the investigators is in the reproductive biology and systematics of polychaetes and echinoderms, especially asteroids and ophiuroids. Studies of the morphology and ecology of epibenthic and recently settled larvae of these two major groups will be conducted to evaluate Thorsen's ideas about reproduction in cold water benthic animals. Thorsen's hypothesis is that marine bottom invertebrates near the poles have non-pelagic development while those nearer the equator have pelagic larval stages. Emphasis will be placed on examination of adult gonads and larvae from epibenthic and midwater plankton samples. All biological samples will remain with the project pending completion of analysis and publication of results; all other materials will be referred to the Smithsonian Oceanographic Center for deposition in the U. S. National Museum.

This proposed research is one of two scientific programs planned for the shakedown cruise of R/V Hero during June and August 1968 in waters between North America and Greenland. Sampling during two crossings of these water masses will permit the use of trawling as well as vertical sampling gear at all points. Station work will include vertical temperature-salinity profiles, plankton casts, and bottom grabs, trawls and dredging. The University shipboard party will consist of four (4) persons. Overside equipment will be provided by USARP.

SUPPORTED BY U.S. National Science Foundation

5.0604, LIFE HISTORY AND DEVELOPMENT OF POLYCHAETOUS ANNELID LARVAE

D. DEAN, Univ. of Maine, Ira C. Darling Ctr. For Res. , *Walpole, Maine* 04573

This study continues work done in a more southerly located estuary under NSF GB-2179. Larvae of as many species of polychateous annelids as possible from the region of the Damariscotta River Estuary are being reared and described. Larvae are obtained from plankton tows and from artificial fertilization. Data are being acquired on breeding seasons, estimates of length of larval life, facility of laboratory spawning, and various other phenomena concerned with reproduction. The behavior of polychaete larvae, offered various substrata during the period of larval settlement and metamorphosis, is also under study.

These data will aid planktologists in the identification of a significant component of the plankton community that has been categorized as 'polychaete larvae unidentified' by most workers. In addition, these data should expand our knowledge on animal-sediment relationships and on the methods of formation of marine benthic communities.

SUPPORTED BY U.S. National Science Foundation

5.0605, ENHANCEMENT OF RECREATIONAL USES OF ESTUARINE WATERS THROUGH STUDY OF POTENTIAL CONTROL METHODS FOR STINGING SEA NETTLES

D.G. CARGO, Univ. of Maryland, Natural Resources Institute, *College Park, Maryland*

Sea nettles, with trailing tentacles heavily armed with stinging cells, seriously interfere with swimming, diving and boating in the Chesapeake Bay and other esturaries. In years of abundance, they are seriously detrimental to the economy of the resort areas and to the recreational activities of the public.

Research will be undertaken by the Chesapeake Biological Laboratory to complete the imperfect knowledge of the principal species, evaluate the role of these organisms in the ecology of the estuaries, examine the relationships which appear to exist between water quality and nettle abundance, and develop and test potential chemical and biological methods for reducing their abundance and the damage they inflict on individuals and the economy of affected areas.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Maryland

5.0606, EVALUATION OF THE ATLANTIC FLYWAY SEA DUCK KILL

S.M. CARNEY, U.S. Dept. of Interior, Mig. Bird Population Station, *Laurel, Maryland* 20810

Objectives: 1. To determine the age, sex and species composition of the sea duck harvest. 2. To determine the distribution of the sea duck harvest and to gain some idea of the extent to which hunters south of New England are taking advantage of the vast sea duck hunting opportunity in this area. 3. To investigate a suspected age segregation in wintering flocks of sea ducks.

Procedures: Data has been gathered through the annual Waterfowl Parts Collection Survey from hunters throughout the coastal States of the Atlantic Flyway where sea duck hunting is permitted. The data will be analyzed by automatic data processing. Tables will be prepared to show species composition by area and time period, age ratios of each species by area and time period and the proportion of the total duck kill that was made up of sea ducks.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0607, THE BIOLOGY OF THE LAYSAN AND BLACK-FOOTED ALBATROSSES

C.S. ROBBINS, U.S. Dept. of Interior, Mig. Bird Population Station, *Laurel, Maryland* 20810

Objectives: In addition to testing effectiveness of scaring and repelling devices, studies include determining effects of habitat management in repelling or attracting birds; measuring repopulation in areas from which nesting birds have been removed; determining dispersal of birds whose nesting areas have been made unsuitable for nesting; determining the incidence of return of young to the place of origin to nest, the age when young return to land, and the length of time required for young to reach breeding age.

To determine age groups in the population, and to compute longevity. To determine the extent of movement of young, nonbreeding and breeding birds between islands; and such related studies on the population dyanmics, distribution, migration and behavior of the Laysan and Black-footed Albatross as will provide information needed for alleviation of thee aircraft hazard without unduly jeopardizing the world population of these seabird species.

Procedures: 1. Band representative samples of the nesting population and of chicks. Through annual recaptures of birds in specific areas, study composition of breeding population, dispersal, relocation, repopulation, minimum and maximum breeding ages, and frequency of breeding. 2. Study bird distribution over the runways and records of bird strikes in relation to weather conditions, habitat, time of day and bird distribution. Test possible methods of reducing the strike rate.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0608, AN EXPERIMENTAL APPROACH TO THE GENETIC CONTROL OF MORPHOGENESIS IN ECHINODERMS

C.H. ELLIS, Amherst College, Graduate School, *Amherst, Massachusetts* 01002

The effects of various treatments, which induce morphological anomalies in sea urchin development will be examined. A study of these effects upon specific gene activities during development will be undertaken. Gene activities are inferred from the synthetic behavior of the several proteins which can be resolved chromatographically at various stages of embryonic development. Correlation between changes at this level and the appearance of visible anomalies will be made. In the case of the development of the larval skeleton, an effort will be made to trace the factors responsible for its absence following the release of prolonged inhibition of gene activity by Actinomycin-D. A careful biochemical analysis of the processes of skeletogenesis is planned, which it is hoped will lead to the elucidation of a complete pathway from DNA-genetic information, through specific protein synthesis, to a structural end-product.

SUPPORTED BY U.S. National Science Foundation

5.0609, ASCIDIAN SPECIES ON THE ATLANTIC CONTINENTAL SHELF

H.H. PLOUGH, Amherst College, Graduate School, *Amherst, Massachusetts* 01002

5. LIVING SYSTEMS (NON-HUMAN)

The Principal Investigator has undertaken the identification and clarification of specimens of Ascidians collected by the Woods Hole Oceanographic Institution's Atlantic Continental Shelf Survey. This material along with other collected independently are accompanied by data which make it possible to plot accurate offshore geographic distributions for the more than forty species of Ascidians found in the Northeastern Atlantic Continental Shelf area, the oceanic area from Nova Scotia to Long Island and out to the edge of the Shelf.

Study of the material shows that there are certain inaccuracies in the distribution currently attributed to some species collected along the shore. In addition, the fragmentary or spotty nature of collecting in the past has given inaccurate limits to the geographic ranges for a number of the offshore Ascidian species. It seems probable also that certain changes in Ascidian distribution have occurred within the recent past, and probably are still going on. Finally, there seem to be quite marked differences in the numbers of individuals of certain species in particular areas and in the same seasons over the past fifty or more years.

Accurate taxonomic identifications and reasonably precise plotting of geographic ranges for sedentary marine species are much to be desired as more effective collecting methods become available. Such data lead to better understanding for marine animals of the determinative factors in the origin of new taxa.

SUPPORTED BY U.S. National Science Foundation

5.0610, PRIMARY STRUCTURE OF INVERTEBRATE HEMOGLOBINS

K.R. READ, Boston University, Graduate School, *Boston, Massachusetts* 02215

A tentative scheme for the evolution of dimeric myoglobins in gastropod subclasses and orders has been worked out. Work is in progress on the characterization of chiton myoglobins and on the subunit structure of the dimeric myoglobin of the gastropod Busycon canaliculatum.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0611, RNA SYNTHESIS DURING SEA URCHIN DEVELOPMENT

D.G. COMB, Harvard University, School of Medicine, *Boston, Massachusetts*

On fertilization of sea urchin eggs, protein synthesis is initiated and much of this early protein synthesized is associated with the mitochondria. We have also demonstrated that a species of lysyl tRNA moves from the soluble fraction of the cell into the particulate fraction after fertilization. Experiments are underway to determine if this species of lysyl tRNA moves into the mitochondria after fertilization and if this may be involved in the activation of mitochondrial protein synthesis.

The second area of investigation is to determine the extent of transcription of mitochondrial and nuclear genes during pregastrula development. We wish to determine how much of the early messenger RNA that is synthesized during pregastrula development is coded for by mitochondrial genes as compared to nuclear genes. Furthermore, we wish to determine if mitochondrial DNA codes for a few or many species of tRNA.

SUPPORTED BY U.S. National Science Foundation

5.0612, COMPARATIVE PHYSIOLOGY OF RESPIRATORY MECHANICS IN MAMMALS

D.E. LEITH, Harvard University, School of Public Health, *Boston, Massachusetts*

We propose to study the physiology of respiration in mammals over a wide range of size, behavior, and habitat, with emphasis upon the mechanical properties of the respiratory system. Our objectives are, fundamentally, two: first, to provide more complete comparative physiological descriptions of respiratory mechanics than are now available for laboratory, domestic, game, and other mammals including groups of special interest such as diving mammals; second, to improve our understanding of general principles governing respiratory function through comparison of mechanical characteristics and response to experimental manipulation of species with different structure and functional requirements.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0613, REASSESSMENT OF TAXONOMY AND EVOLUTION OF ECHINODERMS

H.B. FELL, Harvard University, Museum of Comparative Zoology, *Cambridge, Massachusetts* 02138

The program aims at a reassessment of current views on the taxonomy and evolution of the echinoderms, utilizing modern methods of study of early Paleozoic and pre-Cambrian fossils, and direct comparison of these with living counterparts. The methods used depend upon detailed stereoscopic investigation of structure as preserved in negative moulds in lower Paleozoic and earlier sediments, and comparison of the structures with those of the internal skeleton of extant forms.

Collateral studies will include research on sea-floor photographs from the U.S. Bathyscaph Trieste, and other sea-floor photographs and samples, their analysis for ecological information; systematic reports on expedition material, including U.S. expedition material previously referred to the principal investigator for study in New Zealand, and faunal analyses derived therefrom, leading to biogeographic inferences; and (on the part of the junior investigator) an extension of work previously carried out by him in Antarctica, with the senior investigator's participation, to include taxonomic analyses of deep sea samples, especially those from the Vema expedition, and samples expected from the Eltanin and other cruises.

SUPPORTED BY U.S. National Science Foundation

5.0614, ANATOMICAL INVESTIGATIONS OF THE LOBODONTINAE

B. LAWRENCE, Harvard University, Museum of Comparative Zoology, *Cambridge, Massachusetts* 02138

Collection of specimens of seals of the genera Lobodon, Ommatophoca and Hydrurga involving embalming and latex injection of the blood visceral system. The specimens will be used for study of myological, anatomical and osteological characteristics essential to understanding phytogenetic relationships of Antarctic seal family Lobondontinae.

Collecting will necessitate use of ice breaker and helicopter support in the Ross Sea region and will be supervised by the principal investigator's Field Assistant (Wilson).

SUPPORTED BY U.S. National Science Foundation

5.0615, ECOLOGICAL STUDIES ON TROPICAL INTERTIDAL BRITTLESTARS

A. SCHOENER, Harvard University, Graduate School, *Cambridge, Massachusetts* 02138

No Summary has been provided for use of Science Information Exchange.

SUPPORTED BY Society of The Sigma Xi

5.0616, CILIA DIFFERENTIATION IN THE SEA URCHIN EMBRYO

W. AUCLAIR, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

One of the first morphological manifestations of differentiation in a number of marine invertebrate embryos is the appearance of cilia during the early blastula stage. The primary objective of the proposed project is to gain an understanding at the molecular and cellular levels of the mechanisms leading to the differentiation of these organelles during early embryogenesis. More specifically, the work will deal with a study of the ciliary proteins to determine the number and types of proteins present in cilia, several of their properties, including their size and enzymatic activity, their organization into macromolecular components, and the underlying processes controlling their synthesis and organization to form cilia. The possible relationship of some of the ciliary proteins with the mitotic apparatus proteins, based on preliminary serological work, also will be explored, with the possibility that there may be a reutilization of proteins occurring. With this information it may be possible to gain a better understanding of cellular differentiation in general, and more knowledge of the sequence of overall protein synthetic and macromolecular aggregation events during early development.

SUPPORTED BY Lalor Foundation

5.0617, CILIA DIFFERENTIATION IN MARINE EMBRYOS

W. AUCLAIR, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

Ciliogenesis at the chemical and structural level is being studied during embryogenesis of several species of sea urchins and the marine annelid, Chaetopterus p. The objective is to gain understanding at the cellular and molecular levels of cell differentiation, using the mechanisms leading to the formation of cilia in blastomeres during the blastula stage of embryos.

An analysis of the ciliary protein components and several of their properties are being made in the hope of understanding the process of organization of these proteins and the initiation of this process. The relationship of ciliary protein synthesis to preformed pools of these proteins is also under study.

SUPPORTED BY Lalor Foundation

5.0618, CELLULAR DIFFERENTIATION

L.G. BARTH, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

Our studies continue with the examination of the mechanisms by which various ions can induce the presumptive epidermis of Rana pipiens gastrulae to form nerve and pigment cells. We plan to make an autoradiographic study of the distribution of Ca45 in the cells of the early, middle , and late gastrula as well as the early neurula. Paralllel studies on the uptake of Ca45 by these stages of development will be made with a counter. In addition, we will determine the nature of the sodium dependency of induction by ions--by measuring the total sodium in cells which have been induced by Li plus ions as compared with uninduced cells. The processes going on in the period after induction by Li plus ions will be studied by means of inhibitors.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0619, INTESTINAL ADSORPTION AND TRANSPORT OF NUTRIENTS IN ECHINODERANS

A. FARMANFARMAIAN, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

Intestinal epithelium of Thyone is unique in that it is adapted to Na plus levels of 500 mM/l or higher. Furthermore, while the absorption of sugars obeys Michaelis-Manten kinetics, and the Km for glucose absorption closely resembles those reported for the mammalian intestine, contrary to the mammal, Thyone epithelium does not accumulate glucose. This system will be used to study some of the current problems in the area of membrane transport of sugars. Specifically, answers will be sought to the following questions: Does the carrier have an absolute sodium requirement similar to the mammalian intestine? Is the level of sodium necessary for the maintenance of normal adsorption rates comparable to those reported for mammals (90-150 mM/l) or is it higher for the Thyone intestine which is adapted to media containing approximately 500 mM/l of sodium? What is the stoichiometry of NA-- sugar interaction? Is it 1:1 as has been suggested for the rabbit intestine?

SUPPORTED BY U.S. National Science Foundation

5.0620, ISOLATION AND FUNCTION OF OVARIAN EXTRACTS CAPABLE OF INDUCING COCYTE SHEDDING AND OCYTE NUCLEAR MATURATION IN STARFISH

A.W. SCHUETZ, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

Experimental evidence indicates that shedding of oocytes and oocyte nuclear (germinal vesicle) maturation can be mediated by an ovarian extract. It is proposed to prepare and isolate sufficient amounts of ovarian extract in order to determine physical and chemical properties of the active components and to assess whether one or more ovarian substances are responsible for the different biological effects. Isolation, desalting and purification will be attempted with the physical-chemical methods of electrodialysis, chromatography and filtration. Biological assays will be utilized to trace the biological activity during the process of purification. Changes in oocyte DNA and RNA synthesis prior to and during germinal vesicle breakdown will be investigated in an effort to determine the site of action of the ovarian extracts on the oocyte. The possible existence of a gonadal intermediate (similar to that present in ovarian extracts) in testicular tissue will be investigated.

SUPPORTED BY Lalor Foundation

5.0621, AMINO ACID & PROTEIN METABOLISM IN SCHISTOSOMES

A.W. SENFT, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

Research into the biochemistry and physiology of the parasitic worm Schistosoma, directed toward finding a more effective treatment of the disease Schistosomiasis, and a greater understanding of this and other parasitic infestations.

SUPPORTED BY U.S. National Science Foundation

5.0622, THE ROLE OF CALCIUM IONS IN THE MOTILITY OF SEA URCHIN AND OTHER SPERMATOZOA

J. TIBBS, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

The effect of calcium ion concentration on the adenosine triphosphatase activity of tails isolated from sea urchin and other spermatozoa will be examined by the use of the complexing agent EGTA as a calcium buffer. Attempts will also be made to see whether or not such sperm tails show structural changes during adenosine triphosphate hydrolysis similar to those which have been observed by the author in fish sperm tails (Perca fluviatilis) and whether these changes are dependent on calcium ions.

SUPPORTED BY Lalor Foundation

5.0623, STUDIES OF THE BENTHIC INVERTEBRATES OF THE ATLANTIC CONTINENTAL SHELF

R.L. WIGLEY, U.S. Dept. of Interior, Biological Laboratory, *Woods Hole, Massachusetts*

These studies are designed to describe the communities of benthic invertebrates on the Atlantic Continental Shelf primarily between Nova Scotia and New York; to determine their importance in the ecosystem especially in relation to groundfish predators; and to determine the dynamics of the more important populations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0624, PHYSIOLOGY OF MARINE MAMMAALS

J.W. KANWISHER, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

Some of the thermal and respiratory problems faced by mammals living in the sea have been outlined in the previous application, (GB- 1198). It was shown that water is, at best, a hostile environment for mammalian life and presents obvious difficulties for meeting such needs as air-breathing and the maintenance of a high constant body temperature. In spite of this, several groups have reinvaded the sea and, in the process, evolution has produced some impressive respiratory and thermal capabilities. We know, for instance, that a sperm whale can dive to at least a half-mile and stay down an hour. Just as impressive thermally is the degree to which small seals and porpoises, without access to the efficient air insulating layer of land forms, are at home in freezing water. Due perhaps to the elusive nature of the experimental material, we know only part of the means by which such performances are accomplished. Dr. Kanwisher proposes to extend his studies of such physiological problems in these water-living mammals. Thermal and respiratory physiology will be discussed separately although in any consideration of the living animal they are intimately interrelated. His past work has been on whales and porpoises so most of his thinking centers on the cetaceans. But the seals and sea lions have common physiological problems. And man, for compelling military and economic reasons, is entering the sea with increasing frequency. This research has been supported by NSF Grant GB-1198.

SUPPORTED BY U.S. National Science Foundation

5.0625, ACOUSTIC RECORDING OF MARINE MAMMALS OF NOVA SCOTIA AND NEWFOUNDLAND
W.E. SCHEVILL, Woods Hole Oceanographic Inst., *Woods Hole, Massachusetts* 02543

Woods Hole Oceanogrpahic Institution proposes to conduct a reconnaisance study on the R/V Hero during her shake-down cruise along the continental shelf off Nova Scotia and to St. John's, Newfoundland, via Cabot Straits off Bell Island.

The plan of work calls for a constant look-out during daylight hours for sighting of porpoises, whales, and seals along the cruise track. Sighting will require changes in ship course and speed to close in on the animals as needs dictate. The ship will either lay-to and go on silent conditions for hydrophone recording, or approach for photography or harpooning. In either case, the operation which may entail the launching of the whale boat, would consume from one-half to several hours of work per operation. The research is planned to obtain details on the distribution, seasonal and geographic, of marine animals at sea and particularly to obtain specimens and/or sound recordings of their calls which will enlarge on present pelagic records of cetacean and pinniped species. This work will, in addition, subject the R/V Hero and whale boat to rigorous requirements for underwater acoustic studies which will help in determing possible modifications or other necessary changes prior to the vessel's transfer to Antarctic water.

The principal investigator will be assisted by an acoustic analysis and electronics research associate from WHOI; and, by the Curator of Mammals, Harvard University, who will be responsible for anatomical dissections and photography.

SUPPORTED BY U.S. National Science Foundation

5.0626, RESEARCH ON THE MACROBENTHOS OF THE GREAT LAKES
J.K. HILTUNEN, U.S. Dept. of Interior, Biological Laboratory, *Ann Arbor, Michigan*

The objective of this project is to determine the kinds of bottom dwelling invertebrates and their ecology in offshore areas of the Great Lakes.

Research on freshwater macrobenthos can yield data on the availability of fish food organisms and provide insights into the relationships between species and water quality. Studies of bottom fauna currently undertaken include Lakes Ontario and St. Clair and the Apostle Islands region of Lake Superior. In Lakes Michigan and Erie benthological research is confined mostly to taxonomy and ecology of microdrile oligochaetes. Among aquatic invertebrates, populations of oligochaetes are generally the best indicators of pollution.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0627, REVISION OF GENERA AND SUBGENERA OF WATER MITES OF THE WORLD
D.R. COOK, Wayne State University, Graduate School, *Detroit, Michigan* 48202

This is in a sense three projects grouped administratively under the above title. (1) The presently known water mite genera and subgenera are being reviewed. Many of these are inadequately described and illustrated. Type material in Europe will be examined. A monograph, including illustrated keys, diagnoses, habitat and distribution, will be published in approximately three years. (2) Work on the taxonomy of North American water mites has been impeded by inadequate descriptions of many of the earlier species, especially those from standing water. Recollection of type localities plus work with the types will lead to published studies on several genera in which positive species identifications are now impossible. (3) Work on the taxonomy of water mite larvae will also be carried out. Gravid females of known species are isolated to obtain identified larvae. The lack of good illustrations has made almost all previous work on water mite larvae useless for taxonomic work. Many genera, subgenera and species, in which the larvae were previously unknown, will be illustrated and described. Also the redescription of known larvae will be carried out. Work on larvae should be of interest not only to Hydrachnologists, but to those working with aquatic insects which are so often parasitized by immature water mites. A knowledge of larvae is of great importance in the higher classification of water mites.

SUPPORTED BY U.S. National Science Foundation

5.0628, LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY
R.A. BRAEM, U.S. Dept. of Interior, Biological Station, *Marquette, Michigan*

The Bureau of Commercial Fisheries, under the direction of the Great Lakes Fishery Commission, is using selective larvicides as an experimental method of control for sea lampreys in Lake Superior. The study is designed to eliminate all generations present in the streams tributary to the lake by treatment of these streams with chemical, and to determine if such action will control effectively the parasitism on lake trout and other fish.

The control method requires a thorough knowledge of: the presence and distribution of ammocete populations in tributaries; physical characteristics and flow data of infected streams; accurate bioassays and chemical analyses of the water; precise metering of the chemicals; and posttreatment surveys to measure and analyze the effectiveness of individual treatments.

There are 75 streams tributary to the U.S. shore of Lake Superior containing sea lampreys. The initial treatment of these streams was completed in 1961. The second application was finished in in 1961. The second application was finished 1964. Since then treatments have been repeated at intervals determined from observations on the rate of reestablishment and growth of sea lamprey ammocetes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0629, SEA LAMPREY AMMOCETE REESTABLISHMENT STUDIES
P.J. MANION, U.S. Dept. of Interior, Biological Station, *Marquette, Michigan*

The Bureau of Commercial Fisheries and the Fisheries Research Board of Canada, under contract with the Great Lakes Fishery Commission, are using specific larvicides in the experimental control of the parasitic sea lamprey in the Great Lakes. A complete and thorough knowledge of the larval life stage of sea lampreys is essential for the successful and efficient undertaking of this control program.

The ammocete studies represent a discrete research project designed to provide important life history data. The investigation includes a study of populations reestablished after chemical treatment; magnitude and timing of downstream drift of ammocetes and newly metamorphosed individuals; deep-water populations inhabiting bays, estuarine waters, and inland lakes; and a known-age class of ammocetes isolated in a river free from interference from other age groups or species.

Specifically, the study should provide information on the size of reestablished populations; rate of growth of larvae; minimum duration of the larval stage; downstream drift or movement as influenced by physical and ecological characteristics of given streams; and the relative abundance and distribution of deep-water populations (currently uncontrollable) and some knowledge as to their contribution to the parasitic stocks.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0630, ELECTRIC BARRIER OPERATIONS
H.H. MOORE, U.S. Dept. of Interior, Biological Station, *Marquette, Michigan*

The Bureau of Commercial Fisheries and the Fisheries Research Board of Canada, under contract with the Great Lakes Fishery Commission, are using specific larvicides in the experimental control of the parasitic sea lamprey in the Great Lakes. A means of securing immediate and positive data for evaluating and assessing the effectiveness and progress of the chemical control is essential. A system of electric barriers and traps installed on tributaries to Lakes Superior and Michigan is available for this purpose. These devices are operated during the upstream spawning migration.

The study is designed to provide data measure and abundance, or changes in the population, or sea lampreys; determine geographic distribution of mature adults; and to determine the biological characteristics of the spawning runs. The study also can provide data by which a precise measure of the progressive levels of suppression can be made as well as the best estimate of the final level of control that can be reached.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0631, EFFECTS OF CHEMICALS ON THE PHYSIOLOGY OF SEA LAMPREY AMMOCETES (PETROMYZON MARINUS)

J.H. HOWELL, U.S. Dept. of Interior, Hammond Bay Biolog. Sta. , *Millersburg, Michigan*

Little is known of the physiology of the larval stage of the sea lamprey and still less of the effect of toxic principles on various physiological systems. The basic aims of research in this area are to define physiological norms, determine the mode of function of physiological systems, discover and define systems which are unique in the sea lamprey larvae and correlate this information with observable effects of various toxic principles. Studies are concerned mainly with the amount of physiological disruption which is necessary to produce a lethal response and the relationship of this response to the concentration of a toxic material in the environment. Information is also obtained on the acute and chronic effects of sublethal exposure and the possible role this may play in the development of defensive mechanisms. Where the physiology of sea lamprey ammocetes can be demonstrated to be unique from that of other animals inhabiting the same environment an attempt is made to take advantage of this uniqueness in developing methods for the selective control of these animals.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0632, BIOASSAY

J.H. HOWELL, U.S. Dept. of Interior, Hammond Bay Biolog. Sta. , *Millersburg, Michigan*

Research is directed toward the discovery of chemicals which, when a stream environment, will be selectively toxic to larval sea lamprey (Petromyzon marinus). The procedure consists of bioassaying a wide variety of organic compounds, representing most of the basic structural classes, under standard conditions against larval sea lamprey and rainbow trout (Salmo gairdnerii). The discovery of a chemical possessing the desired biological activity (toxicity and selectivity for larval lamprey) results in the testing of structurally related compounds. The relation between molecular structure and biological activity are studied and compounds custom synthesized to produce the best possible biological activity. Chemicals selected for field use are tested to determine what effect environmental factors such as water chemistry, temperature, turbidity and light have on their biological activity. Tests are run on promising compounds to determine their toxicity to a variety of game and nongame fish species as well as aquatic invertebrates. Methods are devised for preparing concentrated stock solutions of compounds being considered for field use. Analysis techniques, which are fast and accurate are developed. A chemical's potential as a sea lamprey control agent is evaluated under simulated stream conditions and in carefully controlled experimental stream treatments.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0633, BIOLOGY OF THE LARVAL SEA LAMPREY

A.J. SMITH, U.S. Dept. of Interior, Hammond Bay Biolog. Sta. , *Millersburg, Michigan*

A complete knowledge of the biology of larval lampreys is necessary to take full advantage of control techniques which are directed toward this life history stage of the sea lamprey. Evaluation of control methods requires a thorough knowledge of the factors which control the size, growth and transformation of larval populations. Studies are being conducted or planned to determine the effect of environmental factors such as temperature and water chemistry on developing sea lamprey embryos. Also being investigated is the effect of biologically active chemicals on the sequence and success of embryological development. Taxonomic studies are under way on young-of-the-year ammocetes of the five species found in the Great Lakes. These studies utilize individuals of known parentage. The effects of environmental factors such as temperature and food on ammocete growth and transformation are being studied. This information is vital to an understanding of ammocete distribution and their reaction to an abnormal or hostile environment.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0634, POPULATION DYNAMICS OF ANTARCTIC SEALS

A.W. ERICKSON, Univ. of Minnesota, Graduate School, *Minneapolis, Minnesota* 55455

This proposal is a five-year study on the status of the leopard, crabeater, Ross and Weddell seals of Antarctica. The objectives are to: (1) determine abundance, distribution and migrational characteristics of the four seal species; (2) determine their present population dynamics; (3) obtain basic information on sex ratios, age structure, discreteness of population boundaries and breeding biology for determining corrective management adjustments.

Preliminary review and evaluation of existing data, development of methodology, particularly of census procedures applicable to Antarctica and its environmental conditions, and devising and testing statistically valid procedures of Antarctic seal species, will be carried out in a systematic manner. Experimentation will be carried out with aerial photographic methods, utilizing low and high altitude aircraft; infra red sensing systems with possible satellite applications will be investigated when appropriate to this research.

Two participants will conduct ship and aerial census experiments on USCGC Glacier during the International Weddel Sea Oceanographic Expedition of 1967-68; four participants will begin general reconnaissance and individual species studies in the Ross Sea in 1968- 69.

SUPPORTED BY U.S. National Science Foundation

5.0635, STUDIES ON INTEGRATIVE MECHANISMS OF NEURONS

R.L. PURPLE, Univ. of Minnesota, School of Medicine, *Minneapolis, Minnesota* 55455

Studies on integrative mechanisms of neurons will be pursued on neurons which process visual information within the brain of Limulus, on the receptor field organization (extent and nature of overlapping visual fields) of vertebrate retinal ganglion cells, and on the effects of central feedback (efferent control) on the vertebrate retina. The broad goal of these studies is to provide information on neuronal organization and mechanisms underlying pattern recognition in sensory systems. To this end the above projects will concentrate, where possible, on approaches developed in systems analysis, communication theory, etc., for defining temporal and spatial signal processing capabilities of the units studied.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0636, TREMATODES OF FISHES OCCURRING ON THE WEST COAST OF NORTH AMERICA.

M.H. PRITCHARD, Univ. of Nebraska, Graduate School, *Lincoln, Nebraska* 68508

This project proposes first to complete the study of a collection of trematodes from South African marine fishes. Later, there are plans for a new collection from the southern California-Baja California region of the Pacific Ocean. Comparative and zoogeographical studies will be made with trematodes from many parts of the world which are available in the H. W. Manter Collection at the University of Nebraska.

SUPPORTED BY U.S. National Science Foundation

5.0637, APPLICATION OF BIOTELEMETRY TO THE STUDY OF MARINE VERTEBRATES

H.R. SKUTT, Univ. of New Hampshire, School of Engineering, *Durham, New Hampshire* 03824

Members of the Engineering Design and Analysis Laboratory are working on a research project involving telemetry of electrical activity from the brain of a free-swimming fish. This research project involves the perfection of the physiological technique of implanting electrodes within the gustatory centers of the brains of fishes, and the perfection of an underwater biotelemetry system.

It is possible to record from the unanesthetized fish by means of a direct wire connection. Such techniques produce technical problems. Direct wire recording with moving animals produces distorting of the recording of neutral activity. Movement of the animal also produces an entanglement of his leads. It is for these reasons that telemetered signals from the animals are desirable.

Physiological progress to date centered around two problems: the establishment of a stereotaxix atlas, and the development of techniques to allow surgery in the fish.

Progress in the engineering aspects have included construction of miniature biotelemetry units, investigation of encapsulation techniques, investigation of methods of attaching telemetry units to fish and successful transmission of physiological signals from a fish in a tank of water.

SUPPORTED BY New Hampshire State Government
University of New Hampshire

5.0638, SUCCESSION, SPACIAL AND TEMPORAL DISTRIBUTION, AND BIOLOGY OF BENTHIC ORGANISMS

J. PEARCE, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

Measure rate of larval settlement, colonization and succession of invertebrate epifauna and flora on various surfaces of artificial and natural reefs; the effects of such reef communities on the distribution and ecology of bottom-dwelling infaunal organisms and finfish, and the variations in distribution of invertebrates at latitudinally separated reef sites. The investigation will employ traditional sampling gear such as the Smith-McIntyre Bottom Grab, various dredges, and plankton collecting devices as well as the 'Multiple Disc Sampling Apparatus' recently devloped at Sandy Hook Marine Laboratory. The latter consists of a frame supporting concrete, metal, glass, rubber and wood discs to measure settling rates on different materials. Standardized collecting, preserving and laboratory procedures have been established to insure highly quantitative results.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0639, CARDIOVASCULAR STUDIES ON DIVING MAMMALS

F.L. FERRANTE, New Jersey Coll. Med. & Dent. , School of Medicine, *Jersey City, New Jersey* 07304

The present proposal is based on the hypothesis that vagally mediated bradycardia is an essential component of the cardiovascular pattern of adaptation to protracted apnea displayed by diving mammals such as the seal. The present proposal describes experiments designed to establish the nature and extent of hemodynamic disadvantage produced during submergence apnea when the heart is prevented from slowing. Unanesthetized nutria will be tethered to a platform and apnea will be produced by tilting the assembly enough to completely immerse the head under water. Nutria tolerate this procedure since submergence is a natural event for this species.

The normal pattern of onset and intensity of inotropic and chronotropic cardiac changes during submersion apnea will be established as well as the concurrent alterations in aortic flow and resistance. The degree of derangement of the normal pattern by thoracic vagotomy will be established. In other animals the vagi will be left intact and bradycardia will be reversed by electrical pacing of the SA node. The following criteria will be employed to signify hemodynamic disadvantage: a) a more rapid rate of decline of arterial p02 than normally found during submergence. b) a marked rise in right atrial pressure concurrent with a fall in cardiac output. c) marked cardiac dilation concurrent with a reduced force of contraction.

Shifts in the onset and intensity of the selected criteria will be noted.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0640, ULTRASTRUCTURE OF VARIOUS MARINE AND BRACKISH WATER ORGANISMS

F.L. SCHUSTER, City University of New York, Graduate School, *Brooklyn - Brooklyn College, New York* 11210

Investigations have and are being carried out, using the electron microscope, on ultrastructure of various marine and brackish water organisms. Particular emphasis is being placed on various aspects of development and differentiation, both at the organismic and cellular level.

SUPPORTED BY Brooklyn College

5.0641, THE CETACEAN BRAIN - A COMPARATIVE STUDY

M.S. JACOBS, New York Zoological Society, *New York, New York*

Continuing studies of the cetacean brain will be based on a series of gross dissections, on the analysis of five serially sectioned and stained delphinid brains, on additional quantitation of fibers in peripheral nerves and on an investigation of the visual system in Tursiops truncatus, the bottlenose dolphin, using Nauta fiber degeneration staining methods.

Such continuing investigations constitute a variety of approaches to substantiating, in terms of the brain of present day Cetacea, the concept that the brain - through an evolutionary process of addition of new structure upon previously existing structure - has come to consist of, in primates, rhinic, limbic and supralimbic lobes. Having already completed an investigation of the rhinic lobe (paleocortex and archicortex) in Cetaceae in general and in the bottlenose dolphin in particular, the next subdivision of the forebrain that will be concentrated on is the limbic lobe.

In the dolphin, as in primates, the limbic lobe consists of a series of lobular configurations whose rostro-caudal trajectory is grouped in an arch that coincides with the course of the corpus callosum (parolfactory lobule, supracallosal lobule, retrosplenial lobule and parahippocampal gyrus). The relationship of limbic lobe structures to the surrounding cortical formations will be evaluated chiefly by cyto- and myelo-architectonic means.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0642, SYMBIOSIS OF TROPICAL ZOANTHIDEA AND ZOOXANTHELLAE

T.F. GOREAU, State University of New York, Graduate School, *Stony Brook, New York* 11790

This investigation deals with the metabolic interactions between Zoanthus sociatus (Zoantharia, Anthozoa) and its endosymbiotic zooxanthellae. Z. sociatus is abundant and widespread in Jamaican coral reefs. The species has five major ecovariants, or physiological races, which differ from each other in habitat distribution, size, colour and extent of nutritional dependence upon their contained zooxanthellae. The zooxanthellae themselves may be of more than one species. Biochemical investigations have shown that the zooxanthellae from Z. sociatus secrete between about 30 and 90 per cent of their total photosynthetic production the form of organic compounds that are incorporated into the metabolic system of the animal host. The quantitative and qualitative composition of the xanthellar photosynthetate differs consistently according to the type of Zoanthus.

Amont the substances produced by the zooxanthellae are nucleoside polyphosphates, which raises the question whether the phenotype of Z. sociatus is under partial control of the algal associates through genetic information passed to the animal host by means of complex nucleoside 'messengers'. A reverse feed-back could occur in the event of the endo-symbionts becoming dependent upon the host for certain metabolites. One such case has been found: the zooxanthallae of Z. sociatus cannot synthesize glycine which they obtain from the animal host. Investigations on the metabolite exchanges between the various Zoanthus types and their zooxanthellae are being continued to elucidate their effect on morphological, physiological and ecological diversification of the host species.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0643, THERMAL ACCLIMATION PATTERNS IN PARASITES AND HOSTS

W.B. VERNBERG, Duke University, Graduate School, *Beaufort, North Carolina* 28516

One of the basic problems in biology is to understand the mechanisms by which organisms adjust and survive fluctuations in their environment. During the evolution of parasite-host interrelationships, both species have had to be able to adjust to each other as well as to survive fluctuations in physical factors. The comparative influence of temperature on metabolism and enzymatic activity is being studied in both the hosts and different stages in the life cycle of the trematode, Zoogonus lasius. The first intermediate host is the mud- flat snail, Nassarius obsoleta, the second intermediate host is the polychaete, Leanereis culveri, and the definite host is the toadfish, Opsanus tau. It appears that while the parasite does markedly influence the response of the two intermediate hosts, the response of the parasite is distinctive from that of any of the hosts. Although the thermal lethal limits of the parasite in all stages is approximately the same as that of the definitive host, there is much physiological variation in the response to temperature in different stages of the life cycle.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0644, STUDIES ON MOLTING, GROWTH, AND DEVELOPMENT IN ACORN BARNACLES AND LARVAL DECAPODS

J.D. COSTLOW, Duke University, Graduate School, *Durham, North Carolina* 27706 (NONR)

Objective: The problem of barnacle fouling on Naval vessels and underwater structures involves a complex sequence of endogenous biological activities which are largely endocrinological in nature. A clearer understanding of the endocrine mechanisms involved in the barnacle life cycle may facilitate prevention of their occurrence in the future.

Approach: The origins of endocrine systems are being investigated in the developmental stages of barnacle (larvae) in an attempt to localize the regions and time of appearance of areas of endocrine activity. Additionally, the functional period of these sites of endocrine activity is being studied and the effects of experimental extirpations, injection, and implantation documented. Due to the minute size of the sites of endocrine activity, microlaser techniques will be used to selectively destroy endocrine sites.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0645, STRUCTURAL ANALYSIS OF CELL DIVISION

P.J. HARRIS, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

The main focus of work now in progress is the study of structural changes occurring in the sea urchin egg between the time of the maturation divisions and the first cleavage division. The object is to identify those changes which are involved with larval development as opposed to those which are primarily concerned with cell division, and to relate these changes with biochemical events during this period. If time permits, these studies of nuclear, nucleolar and cortical changes will be extended to cover the development of the blastula up to the time of gastrulation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0646, SYSTEMATICS OF DEEP SEA TREMATODES

J.E. MCCAULEY, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

A study is being made of the trematode parasites of fishes from the deep sea. Although three-fifths of the surface of the earth is covered with at least 1000 meters of water we know almost nothing about the trematode parasites from this region. A preliminary investigation suggests that the deep-sea trematode fauna may be almost as diverse as that from shallower waters. More than 2300 specimens are already in the collection, and more will be collected. Systematic, distributional, and evolutionary studies will be made.

SUPPORTED BY U.S. National Science Foundation

5.0647, PYCNOGONIDA OF THE ANTARCTIC REGIONS

J.W. HEDGPETH, Oregon State University, Graduate School, *Newport, Oregon* 97365

This systematic research on Pycnogonids continues earlier studies of one of the more numerous elements of the benthic Antarctic fauna. The major effort is to taxanomically treat 2,000 specimens accumulated through United States Antarctic Research Program and New Zealand collecting activities. The result of this work will appear in a revisionary monograph. This supplement will provide for unanticipated costs to work at Palmer Station and Hero.

The principal investigator and two assistants (McCain and Stout) will join Hero at Palmer Station for collecting enroute to and at Deception Island during the period December - March 1968/69. Scuba collecting will be carried out by the two assistants.

SUPPORTED BY U.S. National Science Foundation

5.0648, WATER AND SALT REGULATION IN NEREID POLYCHAETES

L.C. OGLESBY, Reed College, Graduate School, *Portland, Oregon* 97202

The proposed study will be concerned with the mechanisms involved in water and salt regulation (osmotic and ionic regulation) in certain nereid polychaete annelids which seem to be in the evolutionary process of developing the ability to live in waters of low salt concentration. Emphasis will be placed on the investigation into three processes of osmotic regulation which are known to occur in certain other organisms, but which so far are only postulated in the polychaetes 1) reduction of the permeability of the body surface to salts and to water; 2) active transport of salts from the medium; and 3) the production a urine hypoosmotic to the blood or coelomic fluids, by the nephridia. Radioisotope techniques will be the most used. Comparisons will be made among species of nereids in which osmoregulatory ability is differently developed, in order to determine which features of the experimental results are of importance in osmotic regulation in low external salt concentrations, and which are more generally present. The study of comparative aspects of water and salt regulation may illuminate basic mechanisms of osmoregulation, a phenomenon found in most higher organisms.

SUPPORTED BY U.S. National Science Foundation

5.0649, SHALLOW WATER MEIOBENTHOS OF THE BERMUDA PLATFORM

B.C. COULL, Lehigh University, Graduate School, *Bethlehem, Pennsylvania* 18015

00NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

5.0650, SYSTEMATIC AND DISTRIBUTIONAL STUDY OF DEEP-SEA ECTOPROCTA (BRYOZOA)

T.J. SCHOPF, Lehigh University, Graduate School, *Bethlehem, Pennsylvania* 18015

The proposed study is directed toward obtaining a better understanding of the biogeography, special environmental adaptations, and phylogeny of deep-sea ectoprocts (Bryozon). Most of the material needed for the study is presently available and has been partly analyzed. It includes approximately fifty species; this is the largest collection of octoprocts from the deep-water of the North Atlantic yet made. The species occur in both erect, foliaceous forms that live on soft bottoms (Gay Head - Bermuda transect) and in encrusting, lamellar types that are limited to hard bottoms (Blake Plateau manganese nodules and rocks of the submarine canyons of the continental slope and continental rise). The goal is to analyze these collections and the literature from the points of view of biogeography, special adaptations for the deep-sea environment and the origins of the deep-sea octoproct fauna.

SUPPORTED BY U.S. National Science Foundation

5.0651, COMPUTOR SIMULATION OF HYDROID COLONIES

M.H. BRAVERMAN, Allegheny General Hospital, *Pittsburgh, Pennsylvania* 15212

This is an attempt to analyze growth regulation in a hydroid colony and to utilize the biological mechanisms involved as a recursive computor program which will generate a pattern which can then be compared with the real hydroid colony. It is an exercise in model building designed to elucidate and to identify possible mechanisms for the expansion of genic specifications.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0652, BIOGRAPHIC STUDY OF THE BENTHOS OF PUERTO RICO AND THE VIRGIN ISLANDS

M. CERAMEVIVAS, Univ. of Puerto Rico, Institute of Marine Biology, *Mayaguez, Puerto Rico*

The investigator proposes to study the biological community distribtuion of the bottom organisms to a depth of 200 fathoms in the area around Puerto Rico, and the Virgin Islands, and analyze this distribution in terms of the movements of the water currents. Since most benthic species are dispersed by planktonic larva, he will put special emphasis on the measurement of surface circulation in the area. Temperature patterns at the surface and at mid-depths will be examined to determine whether a suspected cool sub-surface current extends into the tropical environment of the study area from temperate areas and whether this accounts for the presence on the bottom, of certain species of algae not previously known to occur in tropical latitudes.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0653, WATERFOWL FOOD STUDIES

UNKNOWN, Clemson University, Agricultural Experiment Sta. , *Clemson, South Carolina* 29631

Objectives: 1. To determine specific plants that are being used by wintering waterfowl. 2. To determine the extent that each plant is used and the abundance of each species of plant. 3. To present a description (photograph included) so that plants can be easily identified. 4. To increase the production of these food plants so that adequate wintering waterfowl will be maintained.

Description of Work Proposed: The study is to be both qualitative and quantitative. It is proposed that the following steps will be initiated: 1. A food habits study will be made of waterfowl killed at selected areas along the coastal areas. 2. From these studies plants that are of most value will be selected. The extent and range of abundance of these preferred plants will be determined. Then illustrations of these plants by use of photographs/ drawings will be prepared so that they may easily be identified. These illustrations will be made during the growing season, during bloom or flower period, the fruit seed or tuber if consumed and of the ecological growing conditions. 3. A narrative report of each important plant will be prepared to include its importance, its distribution and means of management if known or can be obtained.

SUPPORTED BY South Carolina State Government

5.0654, ENZYME STRUCTURE AND ITS RELATION TO TAXONOMY

G.B. KITTO, Univ. of Texas, Graduate School, *Austin, Texas* 78712

The long-term research objective of this project is to delineate the applicability of biochemical techniques to taxonomic problems. As a starting point we have chosen to study the taxonomic relationships within a single phylum, the echinodermata. Although this group of organisms, which includes starfish, brittle stars, sea urchins, sea cucumbers and sea lilies, has been the subject of considerable investigation by classical taxonomic techniques such as morphological comparisons, little has been firmly resolved of their relationships to one another. It is hoped that a comparison of enzyme properties and structure may prove useful in clarifying the relatedness of these organisms.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0655, DEEP SEA BENTHOS IN THE GULF OF MEXICO

W.E. PEQUEGNAT, Texas A & M University System, Graduate School, *College Station, Texas* 77843

The purpose of this project is the characterization and qualification of the zoo-benthonic organisms comprising the assemblages found at and below 2000 meters in the Gulf of Mexico. Collections will be made primarily by a newly designed epifaunal skimmer which allows for a quantitative sampling of the upper 5 cm. of the sediments over an area of seven square meters. Further definition of the physico- chemical environment of the benthonic communities will be attained through the use of a wide variety of deep-sea sampling and recording equipment, including specially designed current monitors and high pressure cameras. The semi-annual cruises will cover the depth regimes from 2000 meters to the greatest depth in the Gulf of Mexico, 3800 meters, in 300 meter increments.

As protracted operations from fixed facilities in the oceanic depths become more feasible, so does the need for knowledge of the nature and organization of marine biota in this unknown environment become more crucial. Present concepts are based largely on predictions and extrapolation from shallower waters and from very few actual samplings. Although historically thought to be a biological desert, the depths are now known to be populated by a moderate number of organisms, but representing a relatively large number of species and displaying many bizarre characteristics.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0656, STUDY OF LIFE HISTORY AND ECOLOGY OF SERPULIDAE IN TEXAS COASTAL WATERS

BEHRENS, Univ. of Texas, Graduate School, *Port Aransas, Texas* 78373

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY University of Texas

5.0657, REFERENCE COLLECTION OF GULF MARINE ANIMALS

D.E. WOHLSCHLAG, Univ. of Texas, Graduate School, *Port Aransas, Texas* 78373

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY University of Texas

5.0658, PARASITES OF ANTARCTIC VERTEBRATES AND INVERTEBRATES

W.J. HARGIS, Virginia Inst. of Marine Sci. , *Gloucester Point, Virginia* 23062

The Virginia Institute of Marine Science proposes to conduct laboratory studies for the determination of ecto- and endoparasites collected from Antarctic vertebrate and invertebrate hosts. The collections were made over the austral winter at Palmer Station, Antarctica under GA-684, and GA-684.1. The follow-up laboratory research will consist of curating the materials, and selection of appropriate specimens which will be fixed, stained and sectioned in preparation for morphological studies essential for the completion of the systematic reports.

There is no Antarctic field work planned; the research will be conducted at the Virginia Institute of Marine Science by Staff and graduate assistants.

SUPPORTED BY U.S. National Science Foundation

5.0659, FINE STRUCTURE OF JELLYFISH (CHRYSAORA QUINQUICERA) TENTACLE MUSCLE

F.O. PERKINS, Virginia Inst. of Marine Sci. , *Gloucester Point, Virginia* 23062

The fine structural changes which occur during relaxation and concentration of jellyfish tentacle muscle are being investigated. N-butanol is being used to mechanically and chemically relax the tentacles. The musculature of the ectoderm is under special consideration.

SUPPORTED BY Virginia State Government

5.0660, BENTHIC MARINE FAUNA OF THE UPPER SHELF OFF VIRGINIA

M.L. WASS, Virginia Inst. of Marine Sci. , *Gloucester Point, Virginia* 23062

A total of 70 samples were taken with a 1/5 sq. m. Van Veen grab off the Eastern Shore of Virginia in October, 1967. Sorting, identification and enumeration of fauna was completed in June, 1968. Several communities were sampled and much new information was added to that obtained from four earlier cruises in which a much smaller grab had been used.

SUPPORTED BY Virginia State Government

5.0661, INFAUNA OF LOWER CHESAPEAKE BAY

M.L. WASS, Virginia Inst. of Marine Sci. , *Gloucester Point, Virginia* 23062

Study of composition and dynamics of communities, based on about 630 grabs from the Bay proper, 30 from the Rappahannock River, 200 from the York, 200 from the James and 100 from the Eastern Shore. Work began in 1960, with the most recent effort being in the James. Species encountered up to 1965 are included in a checklist. A student thesis by James Feeley on distribution and ecology of 36 species of amphipods was done in 1968.

SUPPORTED BY Virginia State Government

5.0662, EVOLUTIONARY DIVERGENCE OF DEEP WATER MARINE ANNELIDS

C.P. MANGAM, Coll. of William & Mary, Graduate School, *Williamsburg, Virginia* 23185

The proposed research is designed to elucidate basic aspects of the biology of deep-water marine polychaetes. Quantitative measurements of population density, temperature sensitivity, oxygen consumption, lethal limits of temperature and salinity, and the spontaneous activity of the whole animal will be compared to similar measurements on closely related intertidal species. Qualitative aspects of feeding will be examined, as well as the nature of stimuli which elicit the feeding response. It is believed that the comparison will indicate the course of evolutionary divergence of deep water animals from their shallow water ancestors.

SUPPORTED BY U.S. National Science Foundation

5.0663, EVOLUTIONARY DIVERGENCE OF ONUPHID POLYCHAETES

C.P. MANGUM, Coll. of William & Mary, Graduate School, *Williamsburg, Virginia* 23185

Aspects of the biology of onuphid polychaetes from the continental slope of North America are being compared with those of closely related shelf species.

The range of thermal tolerance by Hyalinoecia artifex, which lives in an extremely stable environment, is somewhat narrower than that of the shelf species H. tubicola and Diopatra cuprea; however, the divergence is not sufficient to explain patterns of distribution. Moreover, the effects of temperature change on metabolism reflect several compensatory mechanisms which would promote adaptation to thermal instability, which the slope species never experiences. We have found similar adaptations in arctic-boreal species (both annelids and crustaceans).

Population density of both H. artifex and D. cuprea is more highly correlated with current velocity than with the nature of the substratum. Since the worms feed by trapping particulate food particles, higher current velocities must increase the availability of food. The feeding response to chemical stimuli emanating from trapped food particles is currently under investigation.

SUPPORTED BY U.S. National Science Foundation

5.0664, OPERANT OSMOTIC REGULATION IN A MARINE ANIMAL

M.E. MEYER, Western Washington State Coll. , Graduate School, *Bellingham, Washington* 98225

Investigations indicate that rats are capable of regulating internal physiological homeostasis by various operant behaviors (Teitelbaum, 1966). For example, behavioral control by rats for food, water, and drugs has been reported (Epstein, 1960; Epstein & Teitelbaum, 1962a, b; Clark, Schuster & Brady, 1961). On the other hand, animals are capable, by means of an operant, of maintaining optimal environmental conditions such as thermoregulation (Weiss & Laties, 1961) and oxygen regulation (Weinstein, 1966). A parallel to the above research involves osmotic or salinity regulation in marine invertebrates. The octopus is a very appropriate organism in that it has a very narrow range of salinity tolerance. Gunter (1950) reports that for the octopus vulgaris of the Atlantic Ocean and the Mediterranean Sea, the range of salinity tolerance is 30. -35. g/kg. An additional feature of the octopus is the apparent ease of this animal to learn. Several studies utilizing the octopus have been reported but the research interest has focused mainly upon the visual, tactile and chemotactile senses (Boycott, 1965; Sutherland, 1959, 1961; Wells, 1962, 1964), and upon the neural basis of memory (Young, 1964). This study is concerned primarily with the concurrent operant regulation of salinity level by the octopus, and with a preliminary investigation of the physiological basis of this regulation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0665, PHYLOGENETIC RELATIONS OF FOSSIL AND LIVING GYMNOLAEMATES

J.P. ROSS, Western Washington State Coll. , Graduate School, *Bellingham, Washington* 98225

The evolutionary development of the gymnolaemates, one of the major groups of the Ectoprocta (moss animals) will be investigated. The moss animals, one of the main fouling organisms on the hulls of ships, have a long geologic history and a wide distribution along ancient and recent shore lines. The early fossil representatives, found in stratified rocks deposited 500 million years ago, evolved during the succeeding 300 million years into many diverse groups. At the end of this period widespread extinction greatly reduced the different groups, and in the succeeding 200 million years new groups evolved to give rise to the abundant and diverse recent bryozoans. By determining relationships of these different groups, based on comparative anatomical studies of recent and fossil forms from many parts of the world, the various lines of evolution within the moss animals will be delineated.

SUPPORTED BY U.S. National Science Foundation

5.0666, CELL DIVISION AND MITOTIC APPARATUS PROTEINS

H.A. WENT, Washington State University, Graduate School, *Pullman, Washington* 99163

The proposed work will encompass two aspects of the mitotic apparatus in sea urchin and sand dollar eggs. One is the molecular origin and fate of this complex and transient structure. This involves examination of the temporal relationship between the synthesis of certain molecular constituents of the mitotic apparatus and their assembly into the definitive structure. It is also expected that some of the constituents will not be synthesized since they will already be on hand in adequate quantities in the unfertilized egg. The second aspect involves the reproduction of centrioles. Some work has already been done on this, but a number of hypotheses must be tested and serious thought and effort must be given to isolation and electronmicroscopical studies of this organelle.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0667, FUR SEAL RESEARCH, PELAGIC INVESTIGATIONS

C.H. FISCUS, U.S. Dept. of Interior, Marine Mammal Biol. Lab. , *Seattle, Washington*

Pelagic research on fur seals by the Bureau of Commercial Fisheries is part of the program of the North Pacific Fur Seal Commission. Results are coordinated by the Commission. Research at near the current level is expected to continue until about 1970-during the term of the existing treaty.

The objectives are to determine the ocean distribution, by age and sex, of fur seals and the extent of intermingling of the populations from various islands, and the food habits with as much information as possible on their effect on other living resources. Pelagic sampling also gives the best data on the reproductive condition of seals by age and on bio-economic questions such as comparison of pelagic and land sealing.

Several hundred fur seals will be collected annually at sea by shooting. The ages, sex, presence of marks, measurements (size), reproductive condition, stomach contents, place of capture, and other details are determined, and tabulated or charted. From these data migration routes, intermingling rates, mortality rates, age of sexual maturity, pregnancy rates, food habits, predators, and related information are determined or estimated.

Collecting is done from chartered fishing vessels over the range from central California to the Boring Sea. Food organisms are collected simultaneously and the food species are identified from a comparative collection. Small boats, shoulder-held guns, 50 mm. harpoon guns, nets, and other equipment are used.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0668, ADMINISTRATION OF WHALING ACT, COMMERCIALLY UTILIZED WHALES

D.W. RICE, U.S. Dept. of Interior, Marine Mammal Biol. Lab. , *Seattle, Washington*

Research on commercially utilized species includes studies on blue, fin, sei, humpback, sperm, and bottlenose whales. Data are collected primarily at commercial whaling stations in California and are directed toward studies of age, growth, reproduction, food, and parasites. In addition whale marking is conducted off California and Mexico to obtain information on whale movements. Data from whaling stations and from marking will both contribute to population dynamics studies. These, in turn, will lead to recommendations of management practices intended to maintain the populations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0669, ADMINISTRATION OF WHALING ACT, PROTECTED AND NON-COMMERCIAL WHALES

D.W. RICE, U.S. Dept. of Interior, Marine Mammal Biol. Lab. , *Seattle, Washington*

Research on protected and non-commercial whales will include studies of anatomy, growth, and reproduction of gray whales from small samples of the animals taken during both the northward and southward migrations and periodic counts from land of migrating gray whales to follow population changes.

Incidentally, or when funds permit, studies of the bowhead whale in arctic Alaska, the killer whale, and other small cetaceans will be pursued.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0670, ADMINISTRATION OF WHALING ACT - DEVELOPMENT OF RESEARCH TOOLS

D.W. RICE, U.S. Dept. of Interior, Marine Mammal Biol. Lab. , *Seattle, Washington*

This project is directed first toward development of marks that are suitable for young nursing whales without excessive injury. Age studies of whales are handicapped by a total lack of known-age animals which must be marked as calves. Marks used for adult whales are not suitable. Secondarily, it is directed toward accumulation of information and development of tools that will improve the efficiency of collecting specimens such as ear plugs, ovaries, testes, etc., from whales at whaling stations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0671, FUR SEAL RESEARCH, POPULATION DYNAMICS

A.Y. ROPPEL, U.S. Dept. of Interior, Marine Mammal Biol. Lab. , *Seattle, Washington*

Fur seal research on the Pribilof islands has the objective of searching out and bringing the Pribilof population to the level of maximum sustained yield.

By means of large scale marking experiments, age classification of the commercial kill, tag recoveries, and mortality and pregnancy rate determinations the number of pups born are estimated. Other estimates are made from marked to unmarked ratios among pups, adjusted by sample counts. Sources of error in estimates, such as mortality from tags, are investigated and the results are incorporated in succeeding estimates.

Related studies on body growth, molt and fur growth, behavior, embryology, and development of dentition in fur seals range from beginning to near completion. Studies of the reproductive status of young females and of males will be intensified.

Assistance in statistical analysis of population data is obtained by contract with the Laboratory of Statistical Research, University of Washington, Seattle, Washington.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0672, FUR SEAL RESEARCH, ANATOMY-BEHAVIOR-MORTALITY

V.B. SCHEFFER, U.S. Dept. of Interior, Marine Mammal Biol. Lab. , *Seattle, Washington*

Hair follicle patterns of pinnipeds to be studied by photographing plastic impressions of sheared skin. Hair fiber number per follicle of various species to be counted. Patterns and fiber number may identify genera.

Effect of different sealskin processes to be tested by determining number of hair follicles per unit area and number fibers per follicle.

Fur seal physiology, anatomy, and pathology, with emphasis on nutrition of the newborn and bacteriology. Assistance in food analysis given by Washington State University.

Data from three seasons of behavior observations to be analyzed and reported on. Some marked animals observed during three seasons.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0673, PHYSIOLOGY OF FERTILIZATION AND NUCLEOCYTOPLASMIC INTERACTIONS IN SEA URCHIN DEVELOPMENT

A.H. WHITELEY, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

Brief Description of Research Project: A study of the chemical events in the early development of sea urchin eggs is underway. Two interrelated lines of research are proposed; one has to do with the change in the cortex of the egg upon fertilization whereby a carrier with enzymatic properties appears which carries orthophosphate into the egg, and the second has to do with messenger RNA appearance and assay during development. Experiments will be done to see if mRNA is involved with the appearance of the phosphate carrier and to see if this carrier is related to another carrying uridine into the egg and phosphorylating it.

One major section of the research, done in collaboration with Dr. Ozaki, is concerned with nucleocytoplasmic interactions in the control of genetic expression during development. Using interspecies hybrid sea urchin embryos where genetic information flow is interrupted at some level, the appearance of specific isozymic forms of certain enzymes will be examined. Enzymes specific for one species of sea urchin fail to differentiate in hybrid embryos. A detailed study is underway to determine whether the failure of these paternal enzymes to be formed is a result of failure in the conversion of the genetic information to active enzyme protein.

SUPPORTED BY U.S. National Science Foundation

5.0674, CARDIOVASCULAR ADJUSTMENTS IN DIVING MAMMALS

M.P. SPENCER, Virginia Mason Research Center, *Seattle, Washington*

(1) To explore special mechanisms of adaptation in comparative physiology and (2) applications of biomedical engineering. Out of these areas we hope to contribute to the broad field of physiological understanding and to find and develop clinically useful ideas.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0675, CARDIOVASCULAR ADJUSTMENTS IN DIVING MAMMALS

M.P. SPENCER, Virginia Mason Research Center, *Seattle, Washington*

(1) To explore special mechanisms of adaptation in comparative physiology and (2) applications of biomedical engineering. Out of these areas we hope to contribute to the broad field of physiological understanding and to find and develop clinically useful ideas.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5F. PLANTS

5.0676, ECOLOGY AND NITROGEN CYCLE IN A MARINE PLANT COMMUNITY

J.J. GOERING, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

The physiological ecology of eelgrass (Zostera marina) communities will be examined in concurrence with the dynamics of the nitrogen cycle in a lagoon on the Bering Sea coast of Alaska. A comparison of natural conditions will be made with an area receiving untreated sewage. This will include an examination of the relationship between the primary producers and nitrogen cycle, with emphasis on the role played by nitrogen in the total productivity of the community. Also to be included is the control of the environment on the growth and morphology of the dominant primary producer, eelgrass. The contribution of organic matter, particulate and dissolved, from the eelgrass communities to near-shore oceanic food webs will also be investigated.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0677, ECOLOGY OF EELGRASS

C.P. MCROY, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

Eelgrass (Zostera marina) meadows form an important portion of the food web in the lagoons and inlets of the Alaska Peninsula on the Bering Sea coast of Alaska. Research has included a geographical and quantitative comparison of benthic plants in the eelgrass communities along the coast of Alaska, and intensive studies on the ecosystem of Izembek lagoon near Cold Bay on the Alaska Peninsula. The work at Izembek has monitored the annual cycle of eelgrass production and hydrographic features of the lagoon. This work began several years ago under the sponsorship of the Bureau of Sport Fisheries and Wildlife. More recently we have studied cycling of inorganic nutrients, especially nitrogen, in the lagoon and of the primary productivity of the phyto- plankton associated with the eelgrass community. In addition to the research on the lagoon, the portion of the Bering Sea adjacent to the lagoon has been surveyed for general oceanographic parameters.

SUPPORTED BY Artic Institute of North America

5.0678, FILM PROJECT (KELP FORESTS)

E.S. HOBSON, U.S. Dept. of Interior, Tiburon Marine Lab. , *Belvedere - Tiburon, California* 94920

A film is being made that will provide the public with a better understanding of the marine life associated with the kelp forests of California, and the importance of this endangered habitat to the sport fishery.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0679, GROWTH LAYERING IN BIVALVED MOLLUSKS - AN AID IN PALEOBIOGEOGRAPHIC INTERPRETATION

C.A. HALL, Univ. of California, Graduate School, *Los Angeles - U.C.L.A.*, *California* 90024

A systematic study of the microtexture of the same or similar year classes of Tivela stultorum will be made throughout its range. The presence of annual growth bands or rings on this species has been documented by others. (A) The mean thicknesses of the 'daily' or fourth-order layers in the second to fourth annual band will be determined. (B) The number and kind of growth layers in (i) the summer and (ii) winter (second-order layers) will be counted. The following questions will be asked: (1) Are there 360 to 365 daily or fourth-order growth layers present between the annual bands or in the first-order layer in Tivela collected at different sites and latitudes. (2) Are there differences in the thicknesses of fourth-order layers that can be correlated with latitude or some other factors. (3) Other than Tivela, which taxa have annual or seasonal growth layers and at what latitudes and in what temperatures of water do those forms with such bands occur? (4) Do taxa from high polar latitudes have slow shell growth, are there 360 to 365 'daily' growth increments as have been noted in taxa from temperate and outer tropical latitudes? (5) Do taxa from near-equator latitudes have seasonal growth bands or layers.

SUPPORTED BY U.S. National Science Foundation

5.0680, RESTORATION, PROPAGATION, AND MANAGEMENT OF MARINE ALGAE

W.J. NORTH, Calif. Inst. of Technology, Graduate School, *Pasadena, California* 91109

The project proposes to develop techniques for establishing commercially valuable kelp beds in barren areas, starting with introduction of kelp spores. Preliminary investigation indicates that such techniques can be developed. Once feasibility is demonstrated, the project will attempt to extend the techniques to other useful algal species, with emphasis on species flourishing in relatively warm water so that such species may be available for growth in areas affected by thermal pollution.

The proposed project is an extension and expansion of work conducted with success under Dr. North's Kelp Habitat Improvement Project, which resulted in re-establishment of significant kelp beds off Southern California by transplantation of mature plants and control of grazing organisms. The Habitat Improvement Project will continue under other sponsorship with the added Sea Grant elements clearly identifiable within the total effort.

To aid in the training of qualified persons for future work in this field, the project includes provision for a teaching program under Dr. North for students retained as research assistants for summer work.

SUPPORTED BY U.S. National Science Foundation

5.0681, DRAG-REDUCING ALGAE

J.W. HOYT, U.S. Navy, Undersea Warfare Center, *Pasadena, California* 91107

This investigator is studying exudates of algae and bacteria as they affect the measurement in towing tanks and at sea. Effort is also underway to determine the polysacchardie chemistry of a typical friction reducing species, and to explore the relationship of algal activity in the ocean.

Determination of the causative factors in the ability of microorg- anisms or their products to reduce drag could lead to the synthesis of compounds which, when used as coatings on ship hulls could materially enhance their speed.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0682, GENETIC REGULATION OF HEMOGLOBIN SYNTHESIS IN ARTEMIA

S.T. BOWEN, San Francisco State College, Graduate School, *San Francisco, California* 94132

The long-term goal of this research is to elucidate the role of structural and regulator genes in the synthesis of hemoglobin in the brine shrimp, Artemia salina. This may be an excellent system for the study of regulator genes in a metazoan because Artemia hemoglobin is an inducible protein which can be readily isolated and characterized and it occurs in a species which is suitable for intensive genetic studies. Shrimps mature in two weeks, making it possible to obtain more than 12 generations in one year. Females produce broods of about 50 nauplii every 6 days throughout their life span of 4-6 months. Of the nine single-locus mutations reported in this species, six have been found in our laboratory. Because Artemia races, when reared in the laboratory, initiate hemoglobin synthesis at different levels of oxygen deprivation, it is possible that they differ in regard to regulator genes.

There are three specific objectives: 1) We plan to determine which environmental factors are needed for maximum synthesis of each of the three hemoglobins. 2) We will determine the mode of inheritance of the three hemoglobins commonly found in wild populations in salterns on San Francisco Bay. More than 100 shrimps have been examined and it is evident that the hemolymph of one shrimp may contain any one hemoglobin, a combination of any two, all three homoglobins, or none at all. There is a sex difference in the distribution of hemoglobins in the wild population. Hemoglobin synthesis will be studied in the progeny of single pair matings in our laboratory stocks which carry a marker on the sex chromosome and in which crossing over is suppressed between the sex chromosomes. 3) We will characterize the hemolymph chromoproteins by dissociation into subunits, determination of molecular weights, and (if time permits) by fingerprinting and amino acid analyses.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0683, GROWTH AND DIFFERENTIATION OF PLASTIDS

A. GIBOR, Univ. of California, Graduate School, *Santa Barbara, California* 93018

Acetabularia, a large single celled green alga offers unusual advantages in understanding the role of the nucleus in the control of the synthesis of the DNA of the chloroplasts. Nuclei of these cells can be removed and the cell is able to carry out normal physiological processes including, presumably the replication of chloroplasts. Thus one may study the effect of the chloroplast DNA freed from control by the nucleus. Another approach that is being followed to demonstrate the genetic role of the DNA in the plastids is to study the nature of the lesions induced in the process of ultraviolet light bleaching of Euglena.

Experiments will be carried out to provide further evidence for the metabolic functioning of an autonomous genetic system in plastids by studying the biosynthesis of their nucleic acids, especially DNA, and by studying the enzymes coded by this DNA. Experiments are planned to determine whether genetic differences occur among plastids or among mitochondria of the same cell.

Possible exchange of genetic material among plastids or mitochondria will be investigated by artifically establishing cell lines with mixed plastid or mixed mitochondrial populations. Micro surgical techniques and localized applications of mutagens such as U.V. and X-rays or combinations of these procedures will be attempted.

The search will be continued for proper isolation procedures and adequate nutrient media to carry on the development and multiplication of plastids in vitro.

SUPPORTED BY U.S. National Science Foundation

5.0684, EFFECTS OF DEPTH ON GROWTH AND REPRODUCTION OF BENTHIC MARINE ALGAE

M. NEUSHUL, Univ. of California, Graduate School, *Santa Barbara, California* 93018

Scuba-diving techniques were employed in the sea to follow the growth of benthic plants on substrate placed in underwater study areas. Laboratory culture was carried out in a sea water supplied greenhouse and in an aquarium facility where light and temperature levels were adjusted to simulate those encountered at depth in the sea. The growth and reproduction of plants in the sea and in the laboratory was compared. Plants in the laboratory under simulated depth conditions grew at rates comparable to, and sometimes in excess of those studied in the sea. Growth rates of red algae (Bossiella and Corallina) in the sea were within a factor of 2 of the laboratory estimates. In most cases plants showed an inhibition at high light intensities, and a wide range of saturation growth (at 5-140 langleys per day).

In some forms (i.e., Dictyopteris zonarioides) growth and reproduction appear to be closely correlated. In others seasonal and lunar periodicity was observed. Many simple, yet cululatively important techniques have been developed for transplanting, measuring and handling larger benthic marine algae under laboratory conditions. It is possible to experimentally cultivate a wide range of larger, benthic marine plants. The results of this continuing program (since July, 1962) are presented more fully in published papers (12); in-press papers (10); and unpublished theses and manuscripts (6).

SUPPORTED BY U.S. National Science Foundation

5.0685, CIRCADIAN RHYTHM IN PHOTOSYNTHESIS IN THE MARINE ALGAE GONYAULAX AND ACETABULARIA

B.M. SWEENEY, Univ. of California, Graduate School, *Santa Barbara, California* 93018

The purpose of this investigation is to study the biochemistry of photosynthesis in Gonyaulax and Acetabularia, with the object of discovering through which of the component reactions of photosynthesis the control of the rhythm is exerted. The studies will be directed toward 1) a comparison of the kinetics of the partial reactions of photosynthesis in cell-free systems at different times in the diurnal cycle, and 2) measurement of photosynthesis in whole cells, utilizing flashing light and specific inhibitors as means of identifying partial reactions and detecting differences correlated with the time in the diurnal cycle. It is hoped that these studies will advance the understanding of the mechanism of timekeeping.

SUPPORTED BY U.S. National Science Foundation

5.0686, COPEPOD CRUSTACEANS PARASITIC ON FISHES

A.G. LEWIS, Univ. of British Columbia, Graduate School, *Vancouver - British Columbia, Canada*

The purpose of the project is to study the collections of copepod fish parasites from Eniwetok Atoll and from Indian Ocean fishes both from a taxonomic and a zoogeographic standpoint. The hydrographic data from cruise 2 of the Anton Bruun will be used in the dicussion of the distribution of the copepod parasites of the pelagic fishes collected during this cruise. The distribution of these copepods, as well as others collected during cruise 2, will be compared with their distribution throughout the world.

SUPPORTED BY U.S. National Science Foundation

5.0687, LARVAL STUDY OF THE LOBSTER

W.A. LUND, State Board of Fish. & Game, *Hartford, Connecticut*

Plankton tows will be taken in Long Island, Fishers Island, and Block Island Sounds in the Atlantic Ocean off Block Island and Long Island in an attempt to locate larval lobsters. A few tows taken during 1965 have been examined for larval lobsters. Some larvae were collected in the Sounds, but better results were obtained in the Atlantic off Montauk.

Information available from the former Lobster Hatchery at Naank, Connecticut, indicates that the majority of lobster eggs hatched in June and early July. It is proposed to closely observe egg development on buried females during the spring. This can be accomplished by fishing our own pots or by sailing with certain commercial lobsterman.

Weekly plankton tows will be initiated in the inshore waters during the latter part of May. The periodicity and duration of the tows will be increased as information is gathered. Day and night tows will be made to evaluate which is the better time to sample. Only surface tows will be made during 1966.

Offshore plankton tows are believed to be necessary if we hope to delineate the population to which the Fishers Island and Long Island Sound lobsters belong. It will be necessary to determine the areas of origin, the transport of the larvae and the probable areas of settlement before we are able to understand the ecology of this animal in this area. An off-shore cruise made on

August 5, 1966, yielded six lobster larvae (three 1st stage, one 3rd stage and two 4th stage). The area sampled is approximately 40 to 55 miles SSE off Montauk, Long Island. This is the only evidence we have on the occurrence of larvae in the Atlantic off Block Island and Long Island. Periodic cruises will begin in June and continue until additional positive evidance is gathered on the offshore occurrence of the larvae.

Part 1 of 3.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Connecticut State Government

5.0688, POPULATION STRUCTURE OF THE LOBSTER

W.A. LUND, State Board of Fish. & Game, *Hartford, Connecticut*

In order to prepare a plan for the rational exploitation of the lobster with the goal of achieveing the best long-term yield, it will be necessary to have information on the structure of the existing population and its distribution. Vital data such as abundance of various sizes, sex ratio within groups, distribution of sexes and size of females at first maturity, are needed to estimate the best theoretical size to harvest the lobster.

The objectives of this sub-project are to investigate the composition of the lobster population in Long Island and Fishers Island Sounds throughout the year. It is proposed to examine this population in the following ways: 1. Examine in port, the catches of commercial lobstermen. 2. Examine the catches as they are hauled aboard certain commercial lobster boats. 3. Fish our own pots to catch, in particular, small lobsters not retained by legal pots. 4. Scuba dive in a few selected localities, on a systematic basis, to determine size structure during most of the year. Some type of identification (marking if necessary) will be made to identify lobsters.

The problems associated with an attempt to determine an unbiased estimate of catch per unit of effort are magnified in this populous area. In addition to the sources of bias enumerated by Hancock and Simpson, the disturbance of pots and the theft of lobsters is highly probable in an area having boat traffic. It will be necessary to fish unbuoyed pots (checked by scuba diver) to evaluate this source of bias.

Part 2 of 3.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Connecticut State Government

5.0689, STRUCTURAL AND FUNCTIONAL ORGANELLE INTERACTIONS

G.B. BOUCK, Yale University, Graduate School, *New Haven, Connecticut* 06520

This research is being conducted to investigate the role of cell organelles in growth and differentiation. Apart from direct electron microscopic observations and autoradiography on differentiating tissues, we believe that by experimentally manipulating tissues in a predictable manner and correlating changes in growth or behavioral patterns with specific subcellular changes, we can gain significant insight into the general problems of morphogenesis. Embryogenesis in certain marine plants seem particularily approachable with these techniques and we are encouraged to believe from our early results that these relatively simple systems can provide fundamental new data on biochemical requirements, organelle ontogeny, and structural interactions during cell differentiation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0690, ECOLOGY OF MARINE ENDOLITHIC ALGAE

S. GOLUBIC, Yale University, Graduate School, *New Haven, Connecticut* 06520

The project deals with the microscopic marine algae living within hard calcareous substrate. It primarily concerns the following problems: 1 - Study of differentiation of the thalli into epilithic and endolithic parts and its taxonomic significance. The question is whether the endolithic forms represent ecologically influenced modifications or highly distinct specialized taxa. 2 - The endolithic environment is colonized by two ecologically different groups of algae: those actively boring the carbonate substrate and those living in the already existing cavities. The study is aimed towards a recognition of the relationship between: a) the boring patterns and the organisms causing them and, b) the boring patterns and the mineralogical properties of the substrate. The results are expected to enable a characterization of the ecological role of different types of endolithes as well as to provide a basis for the interpretation of the boring patterns in fossil record. 3 - Algal boring activity and the lithification process frequently occur together. The question is whether the colonization of endolithic algae influences the lithification process or occurs after lithification is already accomplished.

SUPPORTED BY U.S. National Science Foundation

5.0691, BIOTA OF THE RED SEA AND EASTERN MEDITERRANEAN

W. ARON, Smithsonian Institution, *Washington, District of Columbia* 20560

POWELL

It is proposed that a study of organisms of the Red Sea and Eastern Mediterranean with special reference to the movement of biotic species through the Suez Canal be continued. Surveys of existing organisms and studies in relation to their point of origin are being undertaken jointly by the Smithsonian Institution and the Hebrew University of Jerusalem. Both of the listed organizations incorporate, coordinate, and include research activities of other scientists in other agencies and organizations as necessary to accomplish the research.

SUPPORTED BY Smithsonian Institution

5.0692, CORAL ATOLL FLORA

F.R. FOSBERG, Smithsonian Institution, *Washington, District of Columbia* 20560

Descriptive flora of coral atolls, generally, with correct names, pertinent synonyms, descriptions, native names, if available; statements of distribution and occurrence, citation of specimens.

SUPPORTED BY Smithsonian Institution

5.0693, STUDIES WITH TROPICAL AND SUBTROPICAL M[illegible]OALGAE

[illegible] UNT, Univ. of Miami, Graduate School, *Miami - Coral Ga[illegible]les, Florida* 33124 (AT-(40-1)-3795)

The argument is presented that an extensive and ecologically significant benthic flora of microalgae may exist over much of the shallow continental shelf of southern Florida and the Bahama Banks. It is intended to test this proposition, to build a culture collection of microalgae and other micro-organisms from the benthos and to study their physiology and general biology. There is a particular need to examine uptake of organic substrates both in the light and in the dark as well as the biological interactions between the algae themselves and the algae and other consituents of the microflora and microfauna of the benthos. Such an approach is prerequisite for meaningful assessments of primary production occurring at the surface of the continental shelf sediments. The program, further, should serve in some measure to enlarge our limited understanding of processes of primary production in tropical and subtropical waters and should be intrinsically relevant in the field of microbiology.

A survey cruise will be conducted during 1968 to collect core and other samples in transects across the Continental shelf of Florida and over into the Bahama Banks. These materials will be used to determine the types, abundance and distribution of microalgae especially in the superficial layers of shallow sediments. Cultures will also be set up for detailed lab study.

The collection of algae will be screened to identify species with heterotrophic characteristics and those which demonstrate a capacity to influence the growth rate and physiological activities of other species. Where this seems fruitful, attempts will be made to incorporate any bacteria and protozoa which lend themselves to isolation. Concurrently, studies will be initiated on the utilization of carbon-14 labelled organic substrates, wherever possible employing growth studies as well to serve as a guide and a check on short-term rate measurements.

X

5. LIVING SYSTEMS (NON-HUMAN)

SUPPORTED BY U.S. Atomic Energy Commission

5.0694, DISTRIBUTION OF ANTARCTIC MARINE FUNGI

J.W. FELL, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

A renewal of GA-672 to continue the study on the systematics and ecology of Antarctic marine yeasts, phycomycetes on filamentous fungi aboard the Eltanin. The distribution of marine fungi will be made by sampling various water masses from the Subtropical Convergence to the Antarctic continent. Microbiological stations will be taken every 2-3 degrees over cruise transects, and every 1-2 degrees at the Antarctic and Subtropic Convergences from the surface to bottom waters at standard hydrographic depths with biological samplers (Niskin). Fungal cultures will be prepared aboard ship and returned to the University laboratory for physiological characterization of marine yeasts and taxonomic study of asporogenous yeast and other fungal materials.

Eltanin participation is planned in 1 to 2 cruises; Cruises 34-37 will involve two shipboard persons. Coordination with the Lamont Geological Observatory hydrographic program is essential since there are no provisions for hydrographers.

SUPPORTED BY U.S. National Science Foundation

5.0695, ECOLOGICAL STUDIES OF THE SOUTHEASTERN FLORIDA SEA GRASS COMMUNITY - PRIMARY PRODUCTION BY THALASSIA TESTUDINUM KONIG

L.J. GREENFIELD, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

The objective of this study is to obtain estimates of both the normal and potential maximum contribution of the turtle grass, Thalassia testudinum, to the shallow coastal sea grass community in terms of oxygen and fixed carbon yields. To this end the rates of photosynthesis and respiration under normal conditions of field illumination intensities through the seasons and rates of photosynthesis and respiration at saturation and half-saturation illumination intensities will be determined. Comparisons of the relative contribution of plants having epiphytes with plants cleaned of epiphytes will be made. A study of plant growth under field and semi-controlled conditions may reveal some possible morphological and physiological changes in developing plants. An additional aim is to determine the sites of uptake, pathways and rates of translocation, and sites of accumulation of certain required inorganic nutrients and raw materials. It is hoped that the data obtained from this study, combined with the findings of our previous studies, will permit construction of a model of the dynamics of community interrelationships in the food network of the sea grass communities of tropical shallow coastal waters.

SUPPORTED BY U.S. National Science Foundation

5.0696, CONTINUED STUDIES OF THE SYSTEMATICS AND ZOOGEOGRAPHY OF WESTERN ATLANTIC CAECIDAE

D.R. MOORE, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

The Caecidae are minute marine gastropods. The distribution of the family is circumtropical, but some species are found in cool temperate waters. Approximately 100 species have been described for the Western Atlantic region, but most of the names are synonyms.

It is proposed to monograph the Western Atlantic species. The biology of the living animal and the anatomy of the soft parts will be studied in addition to the study of the morphology of the shell. The generic classification of the family will be reviewed, and relationships with similar gastropods in other families will be considered. The vertical and geographical distribution of each species will also be plotted during the study.

SUPPORTED BY U.S. National Science Foundation

5.0697, COLLECTION AND EXTRACTION OF MARINE INVERTEBRATES AND PLANTS

UNKNOWN, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124 (PH-43-67-1179)

Independently and not as an agent of the Government, the Contractor will exert its best efforts to: 1. Collect and identify various species of marine invertebrates and plants. 2. Extract and lyophilize in 4- gram quantities approximately 100 samples as directed by the Project Officer. 3. Samples prepared will be stored and shipped as required by the Project Officer. 4. Perform large recollections of materials demonstrating activity in the Government's screening program. 5. Prepare and submit interim progress reports and a final comprehensive summary report acceptable to the Project Officer in format, quantity, and frequency.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0698, THE MARINE ALGAE OF VIRGINIA

H.J. HUMM, Univ. of South Florida, Marine Science Institute, *Tampa, Florida* 33701

Since 1942 the principal investigator has been making, opportunistically, collections of the marine algae of Virginia at various seasons of the year along virtually the entire coastline and Chesapeake Bay where salinity normally exceeds 15 o/oo. He has also received and worked over collections made by others. The work is now in completed manuscript form, includes records of about 130 species of benthic algae, keys, descriptions, and a general discussion of the coastal waters of Virginia. Illustrations are yet to be completed. The publication is intended as a guide to the identification of the benthic algae of Virginia as well as a species record and ecological study.

Most of the work has been done at the Virginia Institute of Marine Science, Gloucester Point, Virginia, and has been partially supported by that institution.

SUPPORTED BY University of South Florida
Virginia Institute of Marine Science

5.0699, BIOLOGICAL ACTIVITIES OF MARINE FUNGI

M.S. FULLER, Univ. of Georgia, Graduate School, *Athens, Georgia* 30602

The fungi are common in the oceans as saprophytes, parasites of algae, and invertebrate animals. This research has as its primary objective the aquiring of more precise information on the role of fungi in marine ecology. A group of little known coccoid organisms is to be examined morphologically, physiologically, and biochemically to determine both their evolutionary relationships and potential role in the marine environment. One such organism which may cause the gaping disease of oysters is being examined in greater detail. Two parasites each of marine algae and invertebrates are being subjected to detailed study to elucidate the (1) mechanism of host entry. (2) development of the parasites, and (3) the environmental and internal control of entry and development of the parasites.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0700, EFFECT OF EURASIAN WATERMILFOIL CONTROL PROCEDURES ON WILDLIFE AND OTHER ORGANISMS IN AQUATIC ENVIRONMENTS

J.H. STEENIS, U.S. Dept. of Interior, Patuxent Wlife. Res. Ctr. , *Laurel, Maryland*

Evaluations on control of Eurasian watermilfoil with 2,4-D and diquat reveal that native species of plants are not adversely affected in tidal waters. In fact, these treatments have resulted in released growth of native species, including the more desirable duck food plants.

To date investigations of the Chesapeake Biological Laboratory and Virginia Institute of Marine Science reveal no direct adverse effects on commercial shellfish, crabs and fish, or other associated marine life from recommended treatments on Eurasian watermilfoil with 2,4-D or diquat. However, these toxiciogical studies are not complete.

Guide lines on residue studies of commercial fish conducted by the Chesapeake Biological Laboratory are incomplete.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0701, SYSTEMATICS AND ECOLOGY OF SUBTIDAL BENTHIC MARINE ALGAE

R.T. WILCE, Univ. of Massachusetts, Graduate School, *Amherst, Massachusetts* 01003

There is a paucity of information on the subtidal attached algal vegetation from the Woods Hole area. Studies of seasonal succession, vegetative and reproductive periodicity of members of these communities are unknown. It is also true that we have only a general knowledge of which taxa constitute this flora. Previous studies of the sublittoral benthic algal vegetation have all been based on sporatic dredgings made essentially during the warm months of the year. It is proposed to study the attached algae of four ecologically contrasting habitats in the Woods Hole area during a three year period, a program initiated in preliminary fashion by the Principal Investigator in 1966. Subtidal algal ecology will be studied in situ, described on tape and the algal communities photographed. Regular monthly and bimonthly sampling will be made at the four stations through the facility of SCUBA diving; this routine sampling will be made and data collecting over a long period will provide much new information concerning these plants. This research will culminate in a systematic and ecological treatment of the subtidal flora of the area and include line drawings and photographs, keys to the species and a thorough discussion of species distribution and bibliographic citations.

SUPPORTED BY U.S. National Science Foundation

5.0702, ENVIRONMENTAL EFFECTS ON THE METABOLISM OF MARINE ALGAE

J.A. HELLEBUST, Harvard University, Graduate School, *Cambridge, Massachusetts* 02138

The mechanism and specificity of uptake of organic substrates by marine phytoplankton algae, and the influence of exogenous substrates on their metabolism. The effects of exogenous substrates on the induction of transport systems or enzymes for substrate assimilation. Light and dark effects on transport systems. Light effects on pathways of amino acid synthesis.

The effect of light quality and intensity on the metabolism and excretion of glycolic acid, and the possible role of glycolic acid in the 'light' respiration of marine phytoplankton. Effects of salinity on release of organic substrates by algae, and direct measurements of permeability constants for loss of specific algal metabolites.

The effects of light intensity on the composition and rate of synthesis of alginic acid in Laminaria digitata.

SUPPORTED BY U.S. National Science Foundation

5.0703, LIGHT REQUIREMENTS FOR MARINE ALGAE

G.C. MCLEOD, Tyco Laboratories Incorporated, *Waltham, Massachusetts* (N00014-67-C-0326)

In contrast to the large amount of existing knowledge concerning the photosynthetic mechanisms of higher plants and green algae which contain chlorophyll a and b, little is known of photosynthesis occurring in marine algae which contain the accessory pigments chlorophyll c and either fucoxyanthin or phycobilines. The proposed study will ascertain the spectral requirements of selected marine algae and determine the action spectra of the photosynthetic pigments. This information will aid in the design of a detector with responses equivalent to that of the phytoplankton. Information on existing algal indicator species capable of bacteria-free culture will be compiled and the spectral requirements of these species for growth and pigment synthesis will be studied.

To provide the insight concerning aquatic biological phenomena needed by formulators of Naval operational planning, a vast accumulation of definitive background data is essential. The study of biological population dynamics, for example, with limits and interrelationships defined, could lead to the explanation of many phenomena of potential trouble to the Navy, such as plankton blooms, bioluminescence and biological acoustic interference. Research of the type proposed in this study program should serve to eliminate the crucial gaps in our knowledge of factors affecting planktonic marine organisms.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0704, REVISION OF THE CLASSIFICATION AND PHYLOGENY OF THE SUBORDER BALANOMORPHA (CIRRIPEDIA - THORACICA)

V.A. ZULLO, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

It is proposed to undertake a revision of the supraspecific classification and phylogeny of the Suborder Balanomorpha (Cirripedia: Thoracica), or sessile barnacles. This goal will be approached in two ways: 1) through a re-evaluation of previous systematic literature and the examination of the collections upon which these earlier studies were based; and 2) through additional field collection and examination of unstudied collections in various museums. The results of this study will provide a more useful, more flexible, and up-to-date replacement for a classification which has not been examined critically in the last fifty years.

In addition to the revised classification, an annotated and illustrated catalog of the known species of Balanomorpha will be compiled, together with biogeographic data and aids for the non-specialists, including illustrated keys, glossary, and bibliography.

SUPPORTED BY U.S. National Science Foundation

5.0705, SEASONAL VARIATIONS OF ALGAL POPULATIONS

R. OGAWA, U.S. Dept. of Interior, Biological Laboratory, *Ann Arbor, Michigan*

The purpose of this project is to correlate seasonal variations in algal populations in the field with laboratory studies of their nutrient requirements.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0706, NUTRIENT REQUIREMENTS OF ALGAE

R. OGAWA, U.S. Dept. of Interior, Biological Laboratory, *Ann Arbor, Michigan*

The purpose of this project is to gain insight on the effect of increased levels of nitrates and phosphates on unialgal cultures. Present investigations are primarily concerned with blue-green algae.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0707, TAXONOMY AND ECOLOGY OF NEARSHORE MARINE OSTRACODA

F.M. SWAIN, Univ. of Minnesota, Graduate School, *Minneapolis, Minnesota* 55455

Many efforts have been made to determine environmental conditions of early geologic periods through study of fossil remains in sedimentary materials. Because certain living organisms are identical or closely related to fossil forms, it is possible to use knowledge of existing marine environmental conditions to speculate with some assurance regarding the conditions under which earlier organisms lived. Although recent observations suggest ostracodes to be suitable organisms for such studies, their value in paleoenvironmental work is hampered by incomplete knowledge of living coastal species and of their ecological associations and other biodynamic features.

The marine and freshwater ostracodes of the west coast of North and South America from Alaska to Nicaragua have been the subject of intensive investigation. Collections of recent marine Ostracoda from Corinto Bay and Bahia San Juan de Sur, Nicaragua, Bay of Panama, and Cape San Lucas and Straits of Juan de Fuca are to be analyzed for distribution of species and development of biofacies, and correlated with environmental data. The establishment of nearshore ostracode biofacies should provide a basis for the recognition of similar biofacies in the geologic past. It is further proposed to complete a study of a large collection on hand of the late tertiary freshwater beds of the Great Basin, to work out the environmental assemblages and to set up paleontological zones based on the Ostracoda. In order to make adequate comparisons, examination is to be made of museum collections of type species of freshwater ostracodes in London, Newcastle, and Leningrad. The investigation should shed some light on the evolutionary development of certain stocks of Ostracoda.

SUPPORTED BY U.S. National Science Foundation

5. LIVING SYSTEMS (NON-HUMAN)

5.0708, INDUCTION AND CONTROL OF DIFFERENTIATION IN ALGAE

H.W. NICHOLS, Washington University, Graduate School, *Saint Louis, Missouri* 63130

Basic biological properties of multicellular photosynthetic algae, in particular Compsopogon coeruleus, Erythrocladia subintegra, Hildenbrandia rivularis and Polysiphonia urceolata are under investigation. Of major importance will be the elucidation of some aspects of the nutrition and general physiology of the experimental organisms. Secondly, the influence of photoperiod and temperature on the initiation of developmental phases will be examined. Periodic changes in light, coupled with fluctuations in temperature, appear to be directly related to the development of the experimental organisms. Such studies may also reveal some of the controlling mechanisms which govern natural changes in cellular morphology and organization.

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SUPPORTED BY U.S. National Science Foundation

5.0709, CHEMISTRY OF ALGAL TOXINS

M. IKAWA, Univ. of New Hampshire, School of Agriculture, *Durham, New Hampshire* 03824

A project is being undertaken to (a) study the occurrence of toxin-producing algae in local lake, estuarine and marine waters and (b) isolate and characterize toxic substances produced by algae. Toxicity is being determined through assays involving Bacillus megaterium spores, Chlorella pyrenoidosa, and mice. Initial studies are involved with the isolation of toxic substances produced by the blue-green alga Aphanazomenon flos-aguae, which blooms profusely in certain of the lakes in New Hampshire and which is implicated in recent incidents of fish kills, and by the dinoflagellate Gymnodinium breve, which occurs in blooms in the Gulf of Mexico.

The project was started in fiscal year 1968-69. There is no aniticipated completion date for the project.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0710, ECOLOGICAL STUDIES OF THE MARINE RED ALGA CHONDRUS CRISPUS STACKHOUSE

A.C. MATHIESON, Univ. of New Hampshire, School of Agriculture, *Durham, New Hampshire* 03824

The ecology of the red marine alga, Chondrus crispus (Irish moss), will be investigated for the purpose of developing information which can be of use in expanding the amount of this valuable resource in American waters. This alga is one of the principal sources of the phycocolloid, carrageenan, which is widely used as an ingredient stabilizer in many food and pharmaceutical products. Regular observations and measurements will be made at each of four stations in the intertidal and subtidal zones, and the growth and reproduction of in situ plants of Chondrus crispus will be correlated with several environmental factors (temperature, light, salinity, nutrients, tides, substrate currents, precipitation, biological interrelationships, etc). Some of the measurements will involve the use of SCUBA techniques. Also, the growth of cultured germlings, and the photosynthesis and respiration of macroscopic plants will be determined in the laboratory. Other field studies will yield information on succession of the alga in denuded areas, potential usefulness of artificial substrates, effects of grazing by animals regeneration and the propogation capacity following harvesting, and transplantation potential of this species.

SUPPORTED BY U.S. National Science Foundation

5.0711, PRELIMINARY INVESTIGATION OF GROWTH AND DIFFERENTIATION IN MARINE COENOCYTIC ALGA, CAULERPA PROLIFERA

J.C. CHEN, Rutgers The State University, Graduate School, *New Brunswick, New Jersey* 08903

Caulerpa prolifera is a marine coenocytic alga, much larger than most coenocytic organisms, that exhibits interesting and strong abilities for differentiation. It is unicellular in nature and able to differentiate three different 'organs,' namely the rhizome, 'leaf,' and rhizoid cluster.

Two questions about growth and rhizome formation in this alga are being asked: (1) How is the conical shape of the rapidly growing rhizoid tip maintained in the face of the isotropic effects of turgor pressure, and (2) What is responsible for the specific changes that occur in certain regions of the rhizome which initiates the differentiation of rhizoid clusters? Comparative measurements are being made of differential rhizome growth at different points of the rhizome. This will provide some measure of growth rates with respect to each region (point marked out by markers and time-lapse photography of growth). Two additional measurements will then be made (xyian content and birefringence of the cell wall) of each region and these will be related to the specific growth rate to give physical-chemical parameter of that unit portion.

SUPPORTED BY U.S. National Science Foundation

5.0712, MORPHOGENESIS OF THE DIATOM SHELL

B.E. REIMANN, New Mexico State University, Graduate School, *Las Cruces - University Park, New Mexico* 88001

Diatoms are unicellular algae characterized by the presence of a silica shell that encases the cytoplasmic contents. At certain periods during the life cycle of a diatom, i.e., after cell division, during cell extension, and during the formation of zygotes, the cells form new shells by assimilating soluble silicic acid from their environment and depositing it, as polymerized opaline silica, within a membrane system formed inside the living cell. This particular cytoplasmic membrane apparently has the sole function of concentrating silica. Studies are underway concerned with the origin, structure, and function of this very specialized membrane.

The following experiments are underway: 1) electron microscopy of dividing cells to trace the morphology of silicious shell deposition; 2) morphogenetic effects of silicic acid deficiency; 3) relationship between sexual cycles and cell types; 4) effects of osmotic and mechanical pressure, pH, on shell morphology; and 5) localization of silica inside the cell before it is deposited.

SUPPORTED BY U.S. National Science Foundation

5.0713, SYMBIOSIS IN CONVOLUTA

L. PROVASOLI, Haskins Laboratories Inc., *New York, New York*

The main objective is to elucidate the nutritional relationships between the marine flat worm Convoluta roscoffensis and its algal symbionts and how the symbiotic relationships affect the biology of Convoluta.

To determine the specificity of the symbiosis, larvae of Convoluta, which are born devoid of symbionts, were infected artificially with a variety of algae. The algae selected were the natural symbionts isolated from Convoluta worms collected at Jersey Isl., Roscoff and Henday, France, and Pisa, Italy as well as 15 species of free living Platymonas and Prasinocladus; three strains of C. roscoffenis and 1 strain of C. psammophila (Pisa) were reinfected. The natural symbiont of the 4 strains and 2 species of Convoluta was found to be always Platymonas convolutae, Manton at Parke. But 5 Prasinocladus species (and so far no other species of Platymonas) can establish an artificial symbiosis which is almost as effective as the one with P. convolutae. However in competition experiments the natural symbiont wins over the others and can even replace completely the unnatural symbionts after they have established a functional symbiosis. This experimental supremacy of P. convolutae over other species of related algae parallels the ubiquity of this species as the natural symbiont in different strains and species of the convoluta worm. Studies are in progress to find a physiological explanation of this supremacy.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0714, SYSTEMATICS, MORPHOLOGY, AND ECOLOGICAL DISTRIBUTION OF ALGO AND WOOD-INHABITING MARINE AND FRESHWATER FUNGI OF SURTSEY AND ICELAND

T.W. JOHNSON, Duke University, Graduate School, *Durham, North Carolina* 27706 (AT-(40-1)-3556)

Since 1964, the aquatic fungi of Surtsey and Iceland have been under continuing investigation. Prior to 1964 only eleven species had been reported from Iceland. Over two hundred have now been recovered from Iceland (including Surtsey). The purpose of the continuing study is basically ecological distribution, occurrence, and ecological succession of freshwater and marine fungi on the volcanic, submarine upthrust, Surtsey. Developmental morphology and its application to systematics constitute the secondary objective. Collecting-trapping sites have been selected and are being serviced periodically for yield. Standard mycological techniques including baiting of soils and water, and trapping by submerged wood panels are used.

Over two hundred species of aquatic fungi have been recovered. These represent new records, and several are species new to science. Three papers reporting on the occurrence and morphology of some species have been accepted for publication in 1968. Representatives of all classes of aquatic fungi, save for one, have been recovered from Surtsey or adjacent land and water masses.

SUPPORTED BY U.S. Atomic Energy Commission

5.0715, STUDIES OF THE PHAEOPHYCEAN ORDERS CHORDARIALES AND PUNCTARIALES

R.B. SEARLES, Duke University, Graduate School, *Durham, North Carolina* 27706

The work proposed will be a study of the brown algae in the orders Chordariales and Punctariales which occur along the mid-Atlantic coast. Many of the members of this complex have incompletely known life histories and have interesting seasonal and geographical distributions along this coast. Life histories, tolerance to environmental conditions, and responses to changes in conditions will be studied in the laboratory using cultures.

SUPPORTED BY U.S. National Science Foundation

5.0716, MORPHOLOGY AND TAXONOMY OF MARINE FUNGI

J.J. KOHLMEYER, Univ. of North Carolina, Institute of Marine Science, *Morehead City, North Carolina* 28557

A revision of all higher marine fungi described between 1840 and 1940 is planned. Most of these species were incompletely described and their taxonomic position in the modern system remains uncertain. A second goal of the proposed research is to continue investigations on tropical and subtropical marine fungi, expecially composition of the marine mycota in mangrove habitats. In the mangroves, occurrence of terrestrial and marine fungi overlaps, and this study could serve as a basis for future ecological studies on mangrove fungi.

SUPPORTED BY U.S. National Science Foundation

5.0717, QUANTITATIVE AND QUALITATIVE MEASUREMENT OF AQUATIC VEGETATION-CURRITUCK SOUND

T.E. CROWELL, State Wildlife Resources Comm. , *Raleigh, North Carolina*

The objective of this job is to determine the amount and distribution of aquatic vegetation in northern Currituck Sound with particular emphasis upon the apparent immediate and long-range effects upon that vegetation resulting from the salinity artificially created in Back Bay by the City of Virginia Beach, Virginia, and draining therefrom into Currituck Sound. Similar effects by seawater intrusions resulting from natural breaks through the Outer Banks will be determined should such breaks occur.

To accomplish this objective, three samples of aquatic vegetation, each two square feet in area, will be collected with modified oyster tongs at 500-yard intervals across Transect H (Virginia-North Carolina State line), Transect I (Knotts Island to Bench Marsh), and Transect J (Knotts Island to Swan Island). These samples will be collected quarterly (August, November, February, and May).

The percentage volume of each species present in each sample will be determined by an occular estimate and the total volume of aquatic vegetation in each sample will be obtained by displacement following soil removal. Data also will be compiled to provide: total milliliters displaced by each species on a square-foot basis, and the percent frequency of occurrence of each species.

Comparable sampling and data compilation will be effected in the general area of any breaks that may occur naturally through the Outer Banks and result in a sea-water intrusion of significant magnitude.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
North Carolina State Government

5.0718, TAXONOMY OF CALCAREOUS GREEN ALGAE

L.H. COLINVAUX, Ohio State University, Graduate School, *Columbus, Ohio* 43210

The work proposed is a taxonomic study of tropical marine algae, principally of the genus Halimeda, in the Indian Ocean. Extensive new collections were made by me as phycologist aboard the Te Vega on one of her cruises in the International Indian Ocean Expedition. Many additional collections obtained by other investigators participating in the International Indian Ocean Expedition have been sent for study.

The methods used for morphological study will include those found useful in my previous work on the genus Halimeda. Where important, comparisons will be made with related genera. Some cytological studies will be made of the fertile material and pertinent herbarium collections will be examined.

The complete program will provide additional knowledge of the morphology, reproduction, taxonomy and geographical distribution of Halimeda.

SUPPORTED BY U.S. National Science Foundation

5.0719, EXPERIMENTAL CULTURE OF CALCAREOUS GREEN ALGAE OF CORAL REEFS

L.H. COLINVAUX, Ohio State University, Graduate School, *Columbus, Ohio* 43210 (N00014-67-C-0262)

The investigator proposes to identify factors and combinations of factors in the environment which influence the form and growth rate of the calcareous alga Halimeda. This alga is one of the most important of the tropical reef formers, occurring in massive beds in most parts of the world where coral reefs occur and occurring as a major element in sediments. Because of its wide morphological diversity, its taxonomy has not been satisfactorily established. Dr. Colinvaux will attack this problem by experimental culture methods. This research will clarify the role of this alga as an indicator of modern and ancient reef climates.

Calcareous reefs, besides being a navigational hazard, also pose problems for the cutting of channels, harbor construction, and the location of submarine docks. In shallow water coral and calcareous algae rapidly foul submerged equipment; they modify bottom sediments, causing acoustic reverberation, changing the character of the bottom. This study may lead to reef control or at least to predictability.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0720, BIOSYNTHESIS OF 3-HYDROXYTYRAMINE IN MONOSTROMA FUSCUM

R.D. TOCHER, Portland State College, Graduate School, *Portland, Oregon* 97207

We are studying the biosyntesis of 3-hydroxytyramine (3-HT) in the marine alga Monostroma fuscum (Chlorophyta). 3-HT makes up as much as three per cent of the fresh weight of the alga, or about 20% of the dry weight. This alga is, therefore, the richest plant source of this material. Our working hypothesis is that 3-HT is an end-product of the shikimate pathway, although none of the intermediates have been detected. Currently, we are attempting to characterize DOPA decarboxylase in this alga. Of interest is the relationship of the alga's tyrosinase (specifically, the tyrosine ortho-hydroxylase activity) to DOPA-decarboxylase. Tyrosinase would be expected to further oxidize the newly formed DOPA to DOPA-quinone leading to the production of melanins. Instead, DOPA is decarboxylated and ordinarily does not fall prey to further oxidation by tyrosinase.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0721, GROWTH AND CELLULAR MORPHOGENESIS IN NITELLA

P.B. GREEN, Univ. of Pennsylvania, Graduate School, *Philadelphia, Pennsylvania* 19104

Two projects are under investigation which attempt to capitalize technically on the fact that the young and growing Nitella internode is nonetheless a very large cell and thus suitable for physical manipulation. Project No. relation between a single cell's turgor pressure and its relative rate of elongation. Since turgor is believed to be the driving force for growth, its exact relation to the elongation rate is of theoretical interest. This relation has not been worked out for the single growing cell (except in a highly indirect manner) because turgor is traditionally measured by bringing cells into osmotic equilibrium with a known solution. Under these conditions -- no net movement of water -- the cell cannot be growing. The present method utilizes an intra- cellular manometer to measure turgor pressure regardless of whether the cell is in osmotic equilibrium or not. Project No. quantitatively measure the distortions taking place on the expanding curved surfaces of laterals during their initiation in Nitella. Laterals can be artifically induced on young internodes and the details of this process are to be compared with those of normal laterals and the apical cell. These surface expansions are the immediate cause of change in cell shape. They must have their physical basis in the local structure and physiology of small regions of the cell. A tentative mechanism for the physics of the generation of a growth axis will be tested in the study of induced lateral initiation.

SUPPORTED BY U.S. National Science Foundation

5.0722, ECOLOGY OF TROPICAL DEEP WATER ALGAE

L.R. ALMODOVAR, Univ. of Puerto Rico, Institute of Marine Biology, *Mayaguez, Puerto Rico* (N00014-66-C-0330)

Objectives: Problems of bottom modification and biodeterioration are, in part, related to processes by which algae become attached to undersea substrates. The study of the ecology of algae and their succession on submerged structures will bring knowledge of the occurrence and distribution of these and other sedentary organisms to a predictive level.

Approach: Algae samples are being collected on a year-round basis by SCUBA divers in the 20-50 meter depth range and by dredge in the 50-75 meter range. Light, temperature, depth, and salinity data are being recorded for each sampling, as well as a description of each type of bottom encountered. Additionally, the ecological succession of algae on artificial substrates down to the 75 meter limit of algae growth is being studied. In both investigations, algae specimens are appropriately classified and analyzed with respect to the physical environmental data collected and their seasonal and vertical distributions.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0723, MARINE ALGAE OF THE MANGROVE ROOT COMMUNITY

L.R. ALMODOVAR, Univ. of Puerto Rico, Graduate School, *Mayaguez, Puerto Rico*

This grant supports ecological studies of the marine algae of the mangrove root community in Puerto Rico. Constituent organisms will be identified and their physical niche determined; growth rates and fruiting periods of dominant algae will be determined; factors influencing the occurrence and growth of characteristic mangrove species will be studied.

The emphasis will be on experimental ecological work. Apart from identification and determination, animals will be considered only to the extent that they affect the algae (by competing for space upon the roots, by providing surface for algal growth, or in feeding upon or living within the plants). Consideration will be given to the related community of the mud bottom of the mangrove shore and adjacent areas near the mangroves.

SUPPORTED BY U.S. National Science Foundation

5.0724, THE EFFECTS OF POLLUTION ON BENTHIC MARINE PLANT COMMUNITIES

J.T. CONOVER, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

A concentration on algal community metabolism in coastal waters at depths between 15 and 60 feet as related to 'good' and 'bad' waters is being conducted in the Narragansett Bay, Rhode Island to determine how concentrations of metabolites, and waste products in the bay effect plant growth. A modified McClosky method of plating out and obtaining coliform counts is being used to determine animal-pollution gradients while OZR media is used to obtain counts on the natural populations of marine bacteria as an index to natural-pollution levels. Plastic hemispheres, equipped with temperature, light and oxygen probes are employed to obtain photosynthesis rates under certain conditions at various stations in the bay at various depths and pH and alkalinity data are taken to calculate the respiration rate. From these data a P/R ratio is obtained which has been shown to vary with animal pollution gradient. A search is now being made, for optimal and non-optimal growth enhancement habitats as related to the water quality. Incubator experiments will be continued to more precisely determine the effects of specific pollutants upon algal metabolism and to separate and clearify the role of salinity vs. pollution on plant growth. Studies are being continued on the meaning of epibiosis as an index to environmental stress on host plants along with a screening of epiphyte- host relationships morphologically and physiologically among many of the benthic marine plants species. Some work will also be done on the effect of different 'energy levels' upon community metabolism in coastal waters by comparing habitats in slow moving water with those exposed to rapidly moving tidal courrents and turbulance.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0725, ALGAL SUBSTANCES IN THE MARINE FOOD WEB

J.M. SIEBURTH, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

The brown algae are being studied as a model for the role of attached algae in the microbial stages of the food chain. The rate and nature of the production of extracellular organic matter is being studied. Attempts will be made to characterize the phaeophyte polyphenols which seem to be directly involved in the formation of humic substances. The relationship of dissolved humic substances to particulate material will be investigated.

SUPPORTED BY U.S. National Science Foundation

5.0726, DEVELOPMENT OF A METHOD FOR CHRONIC TOXICITY BIOASSAY USING MARINE PLANKTONIC ALGAE

C.S. HEGRE, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab. , *West Kingston, Rhode Island* 02892

Objectives: To develop a method which will permit exposure of algal populations to constant low levels of test compounds, as well as monitoring of population dynamics or metabolic effects.

Procedures: 1. 2. Normal population dynamics and optimal medium exchange rates will be determined. 3. The utility of the apparatus will be tested by determining minimal requirements for a few known nutrients.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0727, STUDY OF NITROGEN METABOLISM IN MARINE ALGAE

C.S. HEGRE, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab. , *West Kingston, Rhode Island* 02892

Objectives: To develop a method based on in vivo enzymatic activity which can be used as a bioassay parameter in determining the biological effects of potential pollutants.

Procedures: 1. An in vivo system for the assay of nitrite reductase activity in marine algae has been established. 2. Environmental factors which influence the expression of nitrite reductase activity will be investigated. 3. Cells preexposed to test compounds will be assayed for nitrite reductase activity. The results of such studies will be compared as indicators of biological effect with those of similar studies in which growth is measured.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0728, MEASUREMENT OF THE RATE OF CARBON DIOXIDE (C14) FIXATION INTO SUBCELLULAR FRACTIONS OF ALGAE

C.S. HEGRE, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab., *West Kingston, Rhode Island* 02892

Objectives: To develop a rapid and sensitive method for detecting the metabolic effects of potential pollutants on cultures of marine algae.

Procedures: 1. Existing procedures for fractionating cells into classes of chemical constituents are being modified to permit processing of many small samples of algae. 2. Optimal labelling conditions and normal incorporation rates will be determined for each fraction. 3. Cultures preexposed to test substances will be allowed to fix Carbon- 14 labeled CO2. The cells will then be fractionated, and rates of synthesis of each fraction will then be determined from isotope incorporation data. Results will be correlated with those of similar studies using growth rate as the measure of biological effect.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0729, ORGANIC INFLUENCES ON CALCIUM CARBONATE CEMENTATION

R. REZAK, Texas A & M University System, Graduate School, *College Station, Texas* 77843

An investigation will be carried out on the role marine algae play in cementation of sediments. Initially a number of species will be collected and grown in pure cultures to allow identification of compounds present in their organic matrices. Correlation of these with the geometrics and crystallographic form of the secretions will be sought.

SUPPORTED BY U.S. National Science Foundation

5.0730, SYMBIOSIS BETWEEN MARINE ALGAE AND INVERTEBRATES

D.L. TAYLOR, Marine Biolog. Assn. of U.K., *Plymouth - Citadel Hill, United Kingdom*

The present work is a study of the physiology, biochemistry and ultrastructure of the symbiotic associations formed between marine algae and invertebrates. The specific purpose of the investigation is twofold, and consists of (1) a study of the taxonomy, distribution and ultrastructure of the organisms involved, and (2) an examination of how these associations are formed and a determination of their significance and potential value to the bioeconomy of the sea.

Previous work has shown that such associations may be divided into two distinct categories, (1) the zooxanthellae-invertebrate association of classical literature, which poses numerous problems of taxonomy, distribution, and significance which are still relatively unknown, and (2) the more recent discovery of chloroplasts functioning as symbiotic organelles in the digestive glands of several species of Opisthobranchs belonging to the Order Saccoglossa. Both of these aspects are being investigated along similar lines, exploring new techniques of utilizing the electron microscope as an instrument of cytological and functional investigation by employing various methods of ultrastructural cytochemistry and autoradiography.

The results of the projected study should provide valuable information relating to the taxonomy and distribution of the species of microalgae involved in zooxanthellae-invertebrate associations, as well as reveal something of the nature and significance of these associations along with others involving chloroplasts as symbiotic organelles.

SUPPORTED BY U.S. National Science Foundation

5.0731, LACUSTRINE AND ESTUARINE FUNGI

R.A. PATERSON, Virginia Polytechnic Institute, Graduate School, *Blacksburg, Virginia* 24061

The proposed research is a continuation of an investigation of lacustrine fungi presently supported by National Science Foundation (GB-2703). It is planned to continue studies on estuarine fungi initiated in September, 1963. Research on these organisms from both fresh and salt waters has two phases. The first is a taxonomic and morphological investigation of fungi which infest plankton. In addition it involves a study of host ranges, host-parasite relationships, and their significance to the taxonomy of the lower fungi. Current studies indicate that research on host ranges will be profitable in clarification of some chytridiaceous taxa. Another aspect of the work on planktonic fungi will be an investigation of the vertical and horizontal distribution of fungal parasites of phytoplankton.

The second part of this program is a study of the occurrence of benthic fungi. The investigator believes these fungi to be more important in the breakdown of dead organic matter in lake and estuarine bottoms than is presently recognized by most limnologists and marine biologists. Some studies of benthic fungi have been made in marine waters, but very few investigations have been conducted in fresh water with the specific purpose of finding benthic fungi. Previous investigation of bottom decomposers have dealt primarily with bacteria, or have employed only bacteriological techniques in studying fungi.

SUPPORTED BY U.S. National Science Foundation

5.0732, ALGAE AS FOOD FOR MARINE INVERTEBRATE LARVAE HELD IN THE LABORATORY

J.L. DUPUY, Virginia Inst. of Marine Sci., *Gloucester Point, Virginia* 23062

Micro algae, especially phytoflagellates, will be isolated from Chesapeake Bay waters, screened for their ability to serve as food for invertebrate larvae held under laboratory conditions. Suitable isolates will be mass cultured and supplied to various user groups as larval food.

SUPPORTED BY Virginia State Government

5.0733, MARINE INVERTEBRATE EXPLORATIONS

D.L. ALVERSON, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Seattle, Washington* 98102

Shellfish explorations are primarily concerned with benthic invertebrate populations. Its ultimate objectives are to define, on a seasonal basis, the quantitative and qualitative distribution of aquatic invertebrate resources having a potential for commercial utilization and to provide an appraisal of those resources. In its full extent, shellfish explorations is a cataloging of benthic invertebrate fauna in time and space.

The area stressed in the Northeastern Pacific and primarily from northern California to southwestern Alaska. The explorations are carried out by the Seattle, Washington based research vessel John N. Cobb.

Shrimp explorations have been conducted in Alaskan waters and off the coasts of Washington and Oregon. Commercial concentrations of shrimp were discovered and the catch ratios were increased by introduction of new gear.

Scallop explorations, initiated in 1963, will be conducted for the next two years. Future explorations include clams, crabs, and reassessment of all commercial invertebrate areas. Biological observations will also be made.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0734, MORPHOGENESIS OF THE DIATOM SHELL

J. LEWIN, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

Diatoms form new silica shells during vegetative cell division and also at other periods during their life cycle. The formation of new silica shells takes place inside the cell. While the silica shell is growing, it is tightly enveloped by a specialized membrane (the silicalemma), which apparently has the sole function of concentrating and solidifying the silica. The origin, structure and function of this very specialized membrane, as well as its relation to adjacent cell contents, will be investigated using cells of several different diatom species in various developmental stages. The research project consists of two closely associated parts, one mainly concerned with the cultural and physiological aspects of the investigation and the other with morphological aspects.

SUPPORTED BY U.S. National Science Foundation

5.0735, PHYSIOLOGY AND ECOLOGY OF MARINE DIATOMS
J.C. LEWIN, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

Studies on the physiology, nutrition, and systematics of marine diatoms in relation to their ecology will be investigated. In particular, species belonging to the important marine genus Chaetoceros will be studied in cultures to clarify their systematics and their nutrient requirements and thus help to explain their natural occurrences. Special attention will also be given to the specific diatom microflora living on the surfaces of sand grains. The most important species will be identified and cultured, and will also be studied in their natural habitat.

Physiological studies which have a direct bearing on measurements of marine primary productivity will be made. These will involve critical investigations of respiration in marine diatoms and other phytoplankton organisms.

SUPPORTED BY U.S. National Science Foundation

5.0736, ASSESSMENT OF LAKE SUPERIOR LAKE TROUT
R.L. PYCHA, U.S. Dept. of Interior, Research Station, *Ashland, Wisconsin*

Control of the sea lamprey and large-scale plantings of lake trout in Lake Superior have brought about a rapid buildup of lake trout stocks. Close surveillance of the changes in the juvenile, legal sized, and spawning stocks is required for rational utilization in the future. Data currently utilized are collected by contract fishermen using conventional commercial gear and by the Bureau's research vessel Siscowet using experimental gill nets and trawls.

Present research, designed to assess the rehabilitation of the lake trout, includes inquiry into: changes in abundance of the size groups of the commercial portion of the artificially propagated lake trout to the commercial catch and the relative success of various hatchery plants; changes in age structure and growth rates of the populations; comprehensive evaluation of the effect of hatchery-reared fish on the juvenile and spawning populations; differences in the habits and distribution between hatchery-reared and native lake trout; the identities and biological features of discrete offshore populations; and the relationship between lamprey predation and the size of the lamprey population. Data on food habits and other features of the life history are collected incidentally to other studies.

Techniques and findings of research on lake trout in Lake Superior should aid similar studies on Lakes Michigan and Huron.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5G. MICROORGANISMS – PLANKTON

(see also Chapter 8j For Marine Fouling and Microbial Corrosion)

5.0737, MARINE BIOLOGICAL INVESTIGATIONS - SURFACE ZOOPLANKTON PROJECT
J.C. QUAST, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

A two-year sampling period using Miller High Speed Samplers is completed, the samples have been analyzed, and a summary manuscript is in the terminal stages of completion. The project summarizes the identity and density distribution of common zooplankters in the upper water strata in the Auke Bay vicinity over the sampling period. The bay is regarded as representative of the northeastern part of the 'inside' marine waters of Southeastern Alaska.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0738, DEEP-WATER ZOOPLANKTON OF THE SARGASSO SEA
A.L. BROOKS, Bermuda Biolog. Sta. For Res. , *Saint George, Bermuda*

The investigators are collecting, at monghly intervals for one year, four samples over 500 meter depth ranges down to 2000 meters at Station 'S', 15 miles SE of Bermuda in 1600 fathoms of water. The zooplankton samples are being studied qualitatively and quantitatively. Hydrographic observations and chlorophyll a determinations are being done at the same time. The objective is to gain a better understanding of the plankton of deep water, how it changes through the year at a single station, both in species composition and in mass.

SUPPORTED BY U.S. National Science Foundation

5.0739, ZOOPLANKTON STUDIES IN BIG LAGOON, CALIFORNIA
G. CRANDELL, Humboldt State College, Graduate School, *Arcata, California* 95521

1) Temporal distribution based on biweekly samples taken with a Clarke-Bumpus plankton sampler.

2) Vertical distribution of zooplankton and vertical diurnal migration. Samples collected with a Clarke-Bumpus plankton sampler and water bottles.

Salinity, temperature and oxygen data taken concurrently with all plankton samples.

SUPPORTED BY No Formal Support Reported

5.0740, MICROBIOLOGICAL CONTROL IN NAVY AND MARINE CORPS OPERATING ENVIRONMENTS
N.A. VEDROS, Univ. of California, School of Public Health, *Berkeley, California* 94720

This research is concerned with microbiology as it applies to the Navy operating environment. Studies under this program will help establish which organisms are responsible for fouling and corrosion, or any other form of microbiological deterioration. Other studies will be concerned with performance of man and his equipment in the terrestrial environment. Research involving the effects of hypo-and hyperbaric conditions on the human microbial flora, in both static and aerosolized state will be undertaken.

This effort is directly related to Navy problems in biodeterioration. It is closely associated with the study of problems encountered in closed environmental systems such as found in deep sea habitats.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0741, SYSTEMATIC STUDIES OF CERTAIN MARINE PARASITIC WORMS
W.E. MARTIN, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

This investigation has three quite separate aims within the broad field of marine helminth parasitology. First, life histories of species of the taxonomically enigmatic trematode genus Renicola will be studied, and the results should provide a firm base for identifying species within this group.

The second aim concerns a nematode that is a spiruroid but with the habitat of filarioid. Spiruroids are obtained by ingesting infective stages in intermediate hosts, perhaps always arthropods, whereas filarioids are transmitted by the blood sucking activities of such hosts. Spiruroids localize in the verterbrate in places affording an exit for their eggs but the species in question seems to be an exception. The two groups form one order and helminthologists believe that the filarioids evolved from spiruroids in a manner paralleling that which apparently occurred in sporozoan and haemoflagellate protozoans. Hence the life hsitory of the species in question would be of particular interest.

Thirdly, a new acanthocephalan worm from a marine fish will be studied from various approaches. Little is known concerning the life history of these thorny-headed worms.

SUPPORTED BY U.S. National Science Foundation

5.0742, CHONOTRICH CILIATE PROTOZOANS
J.L. MOHR, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

Chonotrich ciliates, attached vaselike protozoans confined to crustaceans and apparently reflecting in their own evolution something of the evolution of the crustacean hosts, are under monographic study with emphasis on geographic and host distribution, taxonomic relationships, age of group, cytology and ultrastructure through the life cycle, and morphological adjustments to being whipped back and forward through water. Most intense current study is on Locochonas, on the gribbles (Limnoria spp. boring through wood submerged in sea water or through brown algae), on the complex of genera on Leptostracans (Nebalia and related genera), and on the stylochonid genus on whale- lice (Amphipoda:Cyamidea), but materials of all three families (Stylcoborides, Spirochonidae, Chilodochonidae) of the order are under study. The group is presumably cosmopolitan (although materials from Asia are sparse) and may be of Paleozoic origin.

SUPPORTED BY U.S. National Science Foundation

5.0743, DRIFT-STATION BIOLOGY

J.L. MOHR, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007 (NONR)

Qualitative and quantitative studies of biological populations are conducted in deep waters of the Arctic Ocean, over the Continental Shelf and in shallow coastal waters of Northern Alaska. Emphasis is placed upon taxonomy and ecology of pelagic and benthonic plankton as well as on unique aggregations of organisms occurring directly beneath drifting ice. Also investigated are distribution patterns, morphological and physiological adaptations to arctic environments, energy transfer in the food chain and parasitism of animals, including whales.

These studies contribute to knowledge of the total environment of Arctic seas; aid in identification and mapping of layered water masses of differing acoustic properties; establish the role of organisms in marine fouling; define adaption to rigorous environment; and yield basic information on the total economy of Arctic seas.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0744, DRAG-REDUCING ALGAE

J.W. HOYT, U.S. Navy, Undersea Warfare Center, *Pasadena, California* 91107

This investigator is studying exudates of algae and bacteria as they affect the measurement in towing tanks and at sea. Effort is also underway to determine the polysacchardie chemistry of a typical friction reducing species, and to explore the relationship of algal activity in the ocean.

Determination of the causative factors in the ability of microorg- anisms or their products to reduce drag could lead to the synthesis of compounds which, when used as coatings on ship hulls could materially enhance their speed.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0745, DISTRIBUTION AND BIOLOGY OF PACIFIC ZOOPLANKTON

E. BRINTON, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The grant supports the continuation of a large scale study with several objectives. This first objective is an intensive sampling of the Pacific Ocean in order to determine what species occur there. Results thus far indicate that there are fewer species in the oceanic region than in the terrestrial environment which may be accounted for by the fact that fewer niches are available in the ocean, and that genetic variability, spatial barrier formation or selection pressures differ quantitatively from those under terrestrial conditions. Secondly, collection of data distribution of these organisms will continue. The relationship of the shape of certain patterns of defined ranges to the shape of certain water masses will be examined. In addition,attempts will ne made to obtain information on interspecies interactions, and interactions between a species and the physico- chemical characteristics of its environment in order to shed further light on the shape and size of species patterns and on the factors responsible for the maintenance of them. Finally, the information on taxonomy and distribution of zooplankton will be used to define the community structure of these organisms in the sea. With the accumulation of more data on interrelationships among the vertical ranges of species, it is hoped to learn more about the co-occurrence among species within taxa and between taxa.

SUPPORTED BY U.S. National Science Foundation

5.0746, ECOLOGY AND SEDIMENTARY PATTERNS OF FORAMINIFERA

F.B. PHLEGER, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

This involves the quantitative measurement of features of marine environments which affect distributions of organisms. This should be supplemented by ecological laboratory experiments based on the results. Study of marine marshes is another area for investigation. Some data are presented to show the importance of measuring population variability as an index of the relative variation within natural environments. Other areas of investigation are productivity of benthonic foraminifera, re-investigation of depth assemblages, effect of low oxygen content on populations, depth of mixing of sediments, and concentration of trace elements in tests of foraminifera and its effect on the geochemistry of the sediments.

SUPPORTED BY U.S. National Science Foundation

5.0747, ECOLOGY OF MARSH FORAMINIFERA

F.B. PHLEGER, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

Study of the patterns of foraminifera in marine marshes in several areas of the world has been undertaken. The patterns are interpreted in terms of relative rates of deposition of sediment, of organic productivity and of the dynamics of the lagoon or delta area in which the marsh is present.

SUPPORTED BY Amer. Chemical Society

5.0748, MICROZOOPLANKTERS IN THE MARINE FOOD CHAIN

J.D. STRICKLAND, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

Using a submersible sea water pumping system with deckmounted plankton collecting unit, research under this grant includes: 1) an investigation of the vertical distribution of microzooplankton and their relationship to other seston components over the upper 200 m in several different marine environments; 2) a direct comparison of the relative abundance of microzooplankton and larger zooplankters; 3) a study of weekly changes over a five-month period in micro-zooplankton populations in relation to other biological parameters at three inshore locations; and 4) participation in EASTROPAC 76 (Eastern Tropical Pacific Biological Program) cruise during which the vertical distribution of micro-zooplankton at 12 sites in that little-studied ocean region was examined.

Efforts are being made to establish laboratory cultures of micro- zooplankters such as the tintinnid ciliates believed to be important in marine food chains so as to provide experimental animals for trophodynaric studies.

This work is a triparite investigation using the facilities of the

SUPPORTED BY U.S. National Science Foundation

5.0749, STANDING STOCK AND GROWTH OF BACTERIA IN THE SEA

J.D. STRICKLAND, Univ. of California, Inst. of Marine Resources, *San Diego - La Jolla, California* 92038

Studies of the ATP assay have continued during the past year with investigations being made into the ATP content of several phytoplankton organisms as well as several species of marine bacteria. In addition, ATP profiles were obtained on two cruises.

The existence of a large population of small, pigmented, flagellated organisms at great depths in the ocean has been confirmed. Some of these forms are presently in culture as are some unpigmented protozoans from the same samples. Also phytoplankton cells, typical of the euphotic zone, have been cultured from samples obtained from down to 900 meters. Work is in progress to attempt to ascertain how such cells can survive under prolonged deep sea conditions.

A detailed analysis was made of the glucose metabolism of a marine Pseudomonas sp. It is concluded that if one wishes to extend the 'relative heterotrophic potential' method to include such parameters as in situ velocity of substrate utilization and residence time of natural levels of substrate, the velocity of assimilation should not be used. It was found that the amount of C-14 labeled CO2 produced from C-1 and C-3,4 labelled glucose is a better estimate of substrate metabolized. It is believed that the 'relative heterotrophic potential' method should not be extended to include these parameters but should be applied as originally suggested, as a rough survey of heterotrophic activities in the sea.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0750, BIOCHEMICAL STUDIES ON SILICEOUS SKELETAL FORMATION

B.E. VOLCANI, Univ. of California, Graduate School, *San Diego — La Jolla, California* 92038

Electron microscopic studies on the morphogenesis of the wall of N. pelliculosa suggested that the Golgi apparatus give rise to a procession of vesicles which integrate as a compartmented structure in which silicon is concurrently deposited. The role of the Golgi in wall formation will be intensively investigated by histochemical and radioautographic techniques.

Biochemical studies on the formation of the organic material in the wall of N. pelliculosa showed that proteinaceous and polysaccharide materials are formed just prior to and during silicon uptake. Additional polysaccharides are formed after silicon uptake has ceased. The sequence according to which each of the polysaccharides is synthesized will be determined.

A system of sequential column chromatography was developed which enabled us to separate the many unknown ninhydrin-positive compounds found in the diatom wall. A number of pure compounds have thus been obtained, and their chemical characterization will be established.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0751, COMPARATIVE PHYSIOLOGY OF BAROPHILIC BACTERIA

C.E. ZOBELL, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

This proposal provides for investigating the cultural requirements and comparative physiology of barophilic bacteria, meaning those which grow at deep-sea pressures. Such bacteria are to be compared with barophobic varieties, which are adversely affected by increased pressures. Efforts will be made to obtain more species of barophilic bacteria. The most likely source of such bacteria is the deep sea, where pressures up to nearly 1100 atm prevail, but garden soil, shallow- water sediments, and other materials will also be examined for the presence of barophiles. The nutrient requirements, osmotic pressure tolerance, temperature range of growth, and other cultural conditions will be considered in comparing barophilic with barophobic cultures.

Emphasis will be placed upon investigating the biochemistry and physiology of bacteria cultivated at increased pressure, with special reference to protein synthesis, nucleic acids, and various enzyme systems. Cell wall composition, saturation of lipids, and disulfide linkages will be compared.

SUPPORTED BY U.S. National Science Foundation

5.0752, ORGANIZATION OF THE ACADEMYS COLLECTION OF RECENT MARINE, TERRESTRIAL, AND FRESH-WATER INVERTEBRATES

A.G. SMITH, Calif. Academy of Science, *San Francisco, California* 94118

The Academy's Department of Invertebrate Zoology was established in 1960 to curate and maintain a large collection of preserved invertebrates and to make it available for scientific study by workers in invertebrate zoology. As a result of past work, about 14,000 lots representing approximately 150,000 specimens have been curated and arranged systematically on collection shelves. The present project is a continuation of this work on the remainder of the collection, which is estimated to contain 30,000 lots and 300,000 specimens on completion. Special attention is given to the care of many type specimens already in the collections. Lists of these types are now in press for general distribution.

The Academy's objective is to make this collection a permanent centralized repository of preserved invertebrates readily available for research.

SUPPORTED BY U.S. National Science Foundation

5.0753, MICROSTRATIFICATION OF MARINE ZOOPLANKTON

C.M. BOYD, Dalhousie University, Graduate School, *Halifax - Nova Scotia, Canada*

This is a study of physiological factors regulating growth and distribution of marine zooplankton. It attempts to correlate small scale clumping of zooplankters in the water column with environmental inhomogenities. The non-random distribution of zooplankters may be associated with strata or boluses of thermally inhomogeneous water in a larger water column composed of many of these strata of varying size and discreteness. A electronic plankton counting device will be used to determine the spatial distribution and size of individual plankters and simultaneously record the temperature, depth and ambient light intensity at the point of capture. Analog information will be analyzed by computers and plankton collections will be examined microscopically for correlation analysis.

SUPPORTED BY U.S. National Science Foundation

5.0754, ECOLOGICAL SIGNIFICANCE OF PARTICULATE MATTER IN THE SEA

G.A. RILEY, Dalhousie University, Graduate School, *Halifax - Nova Scotia, Canada*

The principal investigator and two associates on the project, Dr. Edward Batoosingh and Barbara Keshwar, completed a study of various factors involved in production of particulate organic matter in sea water by adsorption on bubbles. The paper is now in press in Deep-Sea Research. D. C. Gordon completed a doctoral thesis entitled 'Studies on the distribution and composition of non-living particulate organic matter in the North Atlantic Ocean'. Various projects are underway on relations of zooplankton and bacteria with organic matter, and a Research Associate, Dr. R. O. Fournier, is working on deepwater heterotrophic algae. The principal investigator is writing a review paper on particulate organic matter for 'Advances in Marine Biology'.

SUPPORTED BY U.S. National Science Foundation

5.0755, SYSTEMATICS, BIOLOGY, AND HYDROGRAPHIC RELATIONS OF SOME SPECIES OF CALANUS (CRUSTACEA, COPEPODA)

B.M. BARY, Univ. of British Columbia, Graduate School, *Vancouver - British Columbia, Canada*

This research is concerned with a definitive analysis of the distribution and morphological variation of the copepod genus Calanus, an animal which occupies a primary position among planktonic populations; often dominating a community and covering large areas of the upper sea layers. The investigator is attempting to determine the hydrographic water mass factors which support and/or limit the distinct populations of this animal.

An understanding of the biological and ecological factors that influence distribution of organisms is essential in hydrobiological studies. With information gained from these kinds of studies predictions can be obtained relating to the dispersal and occurrence of pelagic forms of boring and fouling organisms, those capable of acoustic interference and/or luminescence, and those forms which constitute toxic hazards to personnel.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0756, ECOLOGICAL INVESTIGATIONS OF MCMURDO SOUND ZOOPLANKTON

J.L. LITTLEPAGE, Univ. of Victoria, Graduate School, *Victoria - British Columbia, Canada*

Quantitative discrete depth macrozooplankton samples and simultaneous detailed oceanographic observations taken from

1960 to 1962 in McMurdo Sound, Antarctia, are being analyzed, the following specific objectives in mind: (1) Analysis of discrete depth vertical samples to determine the extent and duration of vertical migrations, the species involved in these migrations and the relationship between these vertical migrations and hydrographical and meterological conditions. (2) Initiation of autecological studies on Euchaeta antarctica, Euphausia crystallorophias and other ecologically significant zooplankton. (3) Specific identification of all ecologically significant holoplanktonic zooplankton in the present collections. (4) Analysis of microzooplankton samples with emphasis on the unusually abundant and poorly known Tintinnid fauna.

SUPPORTED BY U.S. National Science Foundation

5.0757, NEW APPROACHES TO BIOFOULING ASSAY

R.J. BENOIT, General Dynamics Corporation, _Groton, Connecticut_

A. Tests indicate that a simple, quick, laboratory bio-assay procedure can be developed for use in marine fouling research. B. The evaluation of anti-fouling coatings in granular form (a new approach) appears to be feasible. C. Three test organisms were evaluated as candidates for a laboratory bio-assay procedure. D. Leaching rates obtained in granular, copper base paints was in the order of 0.1 to 0.3 mg Cu per day from 0.5 gm of powder in 100 ml sea water. The rates were consistently higher in granular paints of small particle size, and increased slightly daily for three days. These leaching rates are comparable to about 100 micrograms Cu/cm2/day and are greater than rates reported in the literature for several copper paints evaluated as coated panels.

SUPPORTED BY General Dynamics Corporation

5.0758, MARINE SULFUR OXIDIZING BACTERIA

R.C. TILTON, Univ. of Connecticut, Graduate School, _Hartford, Connecticut_ 06105

The project concerns the distribution and characterization of marine thiobacilli from waters off coastal New England. Organisms will be isolated and studied as to their environmental and nutritional requirements. New methods will be developed for studying autotrophic marine bacteria in their natural habitat. Representative thiobacilli will be studied intensively for mechanisms of pH regulation.

SUPPORTED BY U.S. National Science Foundation

5.0759, ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM)

R. UKELES, U.S. Dept. of Interior, Biological Laboratory, _Milford, Connecticut_

Recent interest in aquaculture as a means of increasing the worlds food supply and saving commercially valuable species from extinction, has focused attention on the role of unicellular algae in the aquatic environment. The methods of shellfish culture being developed for commercial hatcheries make it necessary to devise means of raising food organisms, namely unicellular algae. We are providing large amounts of unialgal cultures for a pilot plant hatchery and also working on more efficient methods of culture, harvesting and storing algal cells. We have investigated the effects of pollutants found in the environment, as pesticides, herbicides and detergents, on algal growth. The nutritional requirements and effects of antimetabolites on growth of various species are under study, as well as physical factors important in growth, such as pH, temperature, and light.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0760, LIGHT RECEPTOR CONTROL OF THE DIURAL RHYTHM OF ENZYME SYNTHESIS IN THE BIOLUMINOSCENT MARINE DINOFLAGELLATE GONYAULAX POLYEDRA

J.B. BURNETT, New England Inst. Med. Res. , _Ridgefield, Connecticut_ 06877

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY National Council to Combat Blindness Inc.

5.0761, AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE - LABORATORY PROCEDURES

F.C. DAIBER, State Board of Game & Fish, _Dover, Delaware_

Objective: An evaluation of the effects of various types of marshland management on the diurnal and seasonal concentrations of phosphorus and nitrogen in tidal marshes.

Procedures: The water samples collected in the field will be processed in the following manner: 1. Inorganic phosphorus - Reimold, R. J., 1965. An evaluation of inorganic phosphate concentrations of Canary Creek Marsh. This procedure requires that inorganic phosphorus determination be made immediately after sample collection to avoid errors due to sample storage. The determination, a spectrophotometric technique, requires electrical power. 2. Total phosphorus - Water samples for total phosphorus concentrations are processed upon return to the Bayside Laboratory. The sample is oxidized in an ordinary autoclave according to the technique of Menzel, D. and Corwin, N. 1965. This procedure converts all phosphorus to the inorganic form which can then be measured by the technique of Reimold as cited above. 3. Organic phosphorus concentration is determined by the difference between the initially measured inorganic form and the subsequent total phosphorus determination. 4. Nitrate nitrogen - Wood, E.D., F. A. J. Armstrong, and F. A. Richards. 1967. This technique offers extreme accuracy and is easily used in the field. In this new method nitrate is converted to nitrite and then measured as in number 5. 5. Nitrite nitrogen - Strickland, J.D.H., and T. R. Parsons. 1960. A manual of sea water analysis. Fish Res. Bd. Can. 125:71-74. 6. Ammonia nitrogen - Roskam, R., and D. de Langen. 1964. A simple colorimetric method for the determination of ammonia in sea water. Anal. Chim. Acta 30: 56-59. 7. Salinity will be measured by the conductance method using an induction salinometer

The results will be processed for computer evaluation of the various suspected relationships between the phosphorus and nitrogen concentrations and related physical parameters measured. The I.B.M. computer program STUFF (Sixteen Twenty Universal Function Fitter) will be used to determine significant relationships between organic phosphorus, inorganic phosphorus, total phosphorus, nitrate, nitrite, ammonia, salinity, water temperature, air temperature, tide state, time, lunar phase, day of year and weather. Other statistical and graphical techniques may also be employed to interpret the data.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Delaware State Government

5.0762, BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SALT MARSH ENVIRONMENT - LABORATORY PROCEDURES

F.C. DAIBER, State Board of Game & Fish, _Dover, Delaware_

Objective: To enumerate and identify the microorganisms indigenous to various salt marsh environments, and to relate the known metabolic processes of the principal organisms found to the chemical cycles currently under investigation in these marshes.

Procedures: The sediment samples collected in the field will be processed in the following manner:

1. Weighed samples from each sediment horizon will be placed in dilution bottles containing the appropriate diluent, serial dilutions made and the final dilution will be selectively treated to enhance the growth of the organisms believed to be present in the sample. The number of bacteria in each sediment horizon will be ascertained by plating aliquots from each final dilution onto solid growth media. Replicate plates will be made for each sample. After incubation, the colonies growing on the plates will be counted. The number thus attained represents the number of bacteria in the sample when multiplied by the dilution factor.

2. Identification will be made of the more numerous bacteria growing on the enumeration plates. This will be done by standard bacteriological tests. These include biochemical reactions of the bacteria in specially formulated media, and morphological reactions of the bacterial cell to selective stains.

3. Water pH will be measured by means of a pH meter. 4. Water

salinity will be measured by the conductance method.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Delaware State Government

5. LIVING SYSTEMS (NON-HUMAN)

5.0763, BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SALT MARSH ENVIRONMENT - FIELD TECHNIQUES

F.C. DAIBER, State Board of Game & Fish, *Dover, Delaware*

Objective: To enumerate and identify the microorganisms indigenous to various salt marsh environments, and to relate the known metabolic processes of the principal organisms found to the chemical cycles currently under investigation in these marshes.

Procedures: Sediment samples for bacterial analysis will be collected at locations in Delaware tidal marshes which represent the following conditions: unditched marsh exposed to normal flooding, man- made low level impoundments, high level impoundments, and ditched marsh exposed to normal flooding.

Once every two weeks cores will be taken from each station to a depth which represents the sediment horizons of the station. The sample will immediately be removed from the corer and aseptically transferred to clean polyethylene boxes with tight-fitting lids.

The core samples will be transported immediately to the laboratory so that drying will be prevented or minimized before testing.

In addition, sediment temperatures at the time of sample collection will be measured, and water for salinity and pH determinations at each station will also be collected.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Delaware State Government

5.0764, STUDY OF NORTH AND EQUATORIAL ATLANTIC PLANKTONIC FORAMINIFERA

R. CIFELLI, Smithsonian Institution, *Washington, District of Columbia* 20560

The description and determination of abundance and distributional patterns of the present planktonic foraminiferal fauna in the surficial waters of the North and Equatorial Atlantic. Study of the relationship between foraminiferal and water mass distributions.

SUPPORTED BY Smithsonian Institution

5.0765, SYSTEMATICS AND MORPHOLOGY OF THE SIPUNCULID LARVAE OF THE INDIAN OCEAN

M.E. RICE, Smithsonian Institution, *Washington, District of Columbia* 20560

A comparative study will be made of the morphological features of planktonic sipunculid larvae, collected by the International Indian Ocean Expedition, and the findings will be related to the existing descriptions in the literature. Sipunculid larvae have been found in most of the oceans of the world, but in only one instance has it been possible to make a specific identification. Identification will be attempted in this study, but it is probable that final specific identifications will necessitate a study of development, with eggs and sperm of known adults. Sixty-six specimens have been received from the Smithsonian Oceanographic Sorting Center and work on them will commence some time in 1967.

SUPPORTED BY Smithsonian Institution

5.0766, BIOCHEMISTRY OF MARINE ORGANISMS

J.M. LEONARD, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

The standard approach to marine biodeterioration, fouling included, has been to submerge a material in the sea and to observe some relatively gross result after an exposure of weeks or months, or even longer. This approach ignores the less conspicuous chemical and biological successions that are essential to the macro result. We propose laboratory and field studies in which the successions are carefully studied and correlated with the total ecology. Phytoplankton determinations generally have been slow laborious work, with station- by-station sampling as an inadequate substitute for rapid, continuous measurements. Continuous towing of a turbidity-sensing device afford a non-specific indicator of plankton distributions. Two novel spectrophotometric approaches offer promise of (1) rapid survey, from aircraft, perhaps, giving both qualitative and quantitative information, and (2) a laboratory method which avoids the delays and encumbrances of the conventional extraction-colormetric procedures.

(1) Devise and develop methods for determining phytoplanktonic populations (a) in situ by optical scanning, and (b) in the laboratory by spectrophotometric measurements of planktonic deposits on filters. (2) Explore a novel approach to the direct measurement of the density of seawater. (3) Make preliminary measurements of adsorptions on submerged surfaces. (4) Explore means of controlling surface bioluminescence.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0767, BIOCHEMICAL AND BIOPHYSICAL STUDIES OF THE MARINE ENVIRONMENT

D.F. WILSON, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

(a) To correlate the occurrence of specific planktonic microorganisms and their biological and biochemical activities and products with the occurrence and properties of peculiar distributions of matter or energy in the sea. (b) To describe, on an experimental basis, the nature, specific origins, and transformations of organic matter produced in the marine environment by selected microplankters through metabolic activity and by decomposition (autolytic and microbial). (c) To determine whether or not the copepods influence the marine environment significantly enough to necessitate their inclusion in future research on the sources and transformations of organic matter.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0768, TAXONOMY AND ECOLOGY OF INSHORE MARINE MICROBIOTA

J.B. LACKEY, Individual Grants, *Florida*

This envisages publication of an illustrated account, with keys, of inshore marine and brackish water protozoa and microscopic algae, both planktonic and benthic. Their commonness or rareness, cosmopolitan or restrictive distribution will be covered by ecology, especially with reference to pollution, nutrient richness and water poor in nutrients. Regions covered to date are the Atlantic Coast, Florida to Woods Hole, Massachusetts; The Florida Gulf Coast, the California coast, the Island of Oahu and Guanabara Bay, Brazil.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0769, MICROBIAL CORROSION IN THE MARINE ENVIRONMENT

P.L. SGUROS, Florida Atlantic University, Graduate School, *Boca Raton, Florida*

Objective: This research is a comparative examination of the activities of microorganisms related to chemical transformation. Information obtained can be applied to the mechanisms involved in microbial corrosion in the marine environments.

Approach: Research effort will be devoted to determining the metabolic means by which marine fungi degrade carbon under environmental conditions dissimilar to those of terrestrial fungi.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0770, DETERMINATION OF CHLOROPHYLL DERIVATIVES

C.S. YENTSCH, Nova University, Graduate School, *Fort Lauderdale, Florida*

As part of the more general study of the decomposition of plant matter in the opean ocean, the sequence of decomposition of chloroplastic pigments in marine phytoplankton is being investigated. Because of the general sparsity of pigments in oligotrophic waters, certain techniques had to be devised where very small quantities of chloroplastic material could be measured. One of the tools being utilized has been fluorescence. This technique has been indispensible for an examination of the total amount of the pigment as well as some of the derivatives.

The results to date indicate that chlorophyll derivatives are found throughout the euphotic zone in most water masses. Their percentages are much larger near the base of the euphotic zone than in the well-lighted portion. The principle decomposition product appears to be a phaeo-type pigment. This pigment results from chlorophyll losing its magnesium. It is brought about by the action of either organic acids formed by the plants themselves during autolysis or the action of acids being grazed by herbivorous zooplankton.

We have also developed a batch filtration device which has allowed us to concentrate large amounts of particulate matter. By thin-layer chromatography we have been able to separate chloroplastic pigments from the particulant and have found most of the major chlorophylls and the derivatives, phaeophytin, phaeophorbide and chlorophyllide. The amounts of these pigments appear to be highly variable. Factors responsible for conversion of chlorophylls to the derivatives in situ are being investigated.

SUPPORTED BY U.S. National Science Foundation

5.0771, ZOOPLANKTON DISTRIBUTION IN THE TROPICAL ATLANTIC

J.F. HEBARD, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab. , *Miami, Florida*

Phase 1. Distribution of selected species of zooplankton in the surface mixed layer of the tropical Atlantic Ocean. The zoogeographical distributions of zooplankton will be studied. The distributions will be collated with the physical and chemical environment with special attention to areas of divergence, convergence, upwelling, river runoff, and water mass interaction. Seasonal variations in distributions will be examined wherever possible.

Phase 2. The vertical distribution of zooplankton in the Gulf of Guinea. l. The vertical extent of diurnal migrations 2. Modification of vertical distribution by such hydrographic features as undercurrents, thermocline, river effluent, etc. 3. The definition of surface and deep communities and their interactions 4. Variation in adult-to-juvenile ratios as an index to community production, 5. Non-random concentrations of zooplankton as a potential food pasture for tuna forage organisms.

Phase 3. Design and construction of a discrete depth zooplankton sampler. A multiple opening-closing plankton sampler to assess the vertical stratification of zooplankton in the upper 200 meters of the sea will be designed.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0772, ECOLOGY AND TAXONOMY OF TROPICAL ATLANTIC SCOMBRID EGGS AND LARVAE

W.J. RICHARDS, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab. , *Miami, Florida*

Study of systematics, life history, distribution, and abundance of scombrid fish larvae.

Phase 1. Identification, distribution, and ecology of larvae of scombrid larvae from EQUALANT surveys I and II. Phase 2. Distribution and ecology of scombrid larvae in the Gulf of Guinea. The material from EQUALANT III and subsequent cruises will comprise the basis for this study as well as the material from EQUALANT I and II already reported on. Phase 3. Distribution and ecology of scombrid larvae from the western Atlantic. The material from GERONIMO cruises 6, 7, and 8 and UNDAUNTED cruises 2 through 10 will comprise the basis for this study. This study will commence following solution of the problems of identification (Phase 7-9). The material from GERONIMO 8 has been analyzed and a report completed in FY 1967. Phase 4. Food of scombrid larvae. The larval period, from the viewpoint of mortalities, is probably the most critical in the life of the tunas. Therefore, it is essential to know which trophic levels are being preyed upon by these larvae. Phase 5. Distribution and ecology of scombrid eggs. Eggs do not actively move through the water, thus their distributions and numbers will give a more finite answer to the abundance and location of tuna spawning than the distribution of larvae. Inherent difficulties in the identification of tuna eggs delays the start of this phase until reliable methods of identification can be formulated. Phase 6. Ecology of important species other than scombrids, fish eggs, and larvae to be studied from abundant existing material. To commence as opportunity and needs demand. Phase 7. Analysis of external characters of scombrid larvae to delineate scombrid types. Phase 8. Analysis of internal micro-anatomical characters of larvae to delineate types and confirm species' identities with larval types. Phase 9. Taxonomic investigation of scombrid eggs to associate types of eggs with species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0773, GENERAL SYSTEMATIC STUDIES OF THE OCTOCORALLIA OF THE TROPICAL ATLANTIC

F.M. BAYER, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

The proposed research deals with the systematics of tropical Atlantic octocorals. These coelenterates are one of the most important groups of sessile animals in the reef habitat and in many bottom communities of deeper water. Knowledge of the systematics of the West Indian forms has been put seriously out of date by rich collections obtained in the past five years by dredging, trawling and SCUBA diving, and the East Atlantic tropical fauna is very incompletely known. Material from the Straits of Florida, Bahamas, West Indies, Gulf of Mexico, Caribbean Sea, Brazil, and the Gulf of Guinea, now numbering about 900 lots and steadily increasing, will be studied systematically, described, and illustrated, toward two final goals: (1) a revision of the Octocorallia of the continental shelf and slopes of the tropical West Atlantic, and (2) a general account of the octocorals of tropical West Africa. These will include zoogeographical studies to reveal the degree and nature of the faunal relationship of the eastern and western Atlantic; information on geographical and ecological variation of individual species; and studies of the anatomy and histology of as many species as possible, in order to clarify basic questions of classification of higher taxa. The studies now undertaken are the first step toward a thorough modernization of the systematics of the Octocorallia in general, and are preliminary to the investigations of the more complicated (and taxonomically confused) Indo-Pacific fauna. In the two-year period of the present grant, research will be concentrated upon the West Atlantic fauna, and it is anticipated that approximately one-half of the revision of that area can be completed.

SUPPORTED BY U.S. National Science Foundation

5.0774, RELATIONSHIP OF PHOTOSYNTHESIS TO RESPIRATION OF OCEANIC MICROALGAE

J.S. BUNT, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

In recent years, most measurements of primary productivity have been based on the carbon-14 technique introduced by Steemann Nielsen. In attempting to decide whether this method measures net or gross photosynthesis or something in between, comparisons have been made with net rates of oxygen evolution in photosynthesis. It has been conventional to calculate gross photosynthetic activity on the assumption that oxygen consumption continues in the light as it does in the dark. Data based on mass spectrometry have shown that this is not necessarily true. Increased oxygen consumption in the light has been attributed to processes leading to ATP formation. With this evidence at hand, studies were initiated in these laboratories to determine whether changed rates of oxygen consumption are general among marine microalgae and to identify environmental factors influencing oxygen consumption in the light. While this work was in progress, reports appeared indicating that another process, photorespiration, may be significant in photosynthesizing tissue and that photorespiration is influenced by oxygen concentration. This information forced a re- evaluation and extension of experiments in this laboratory. Progress has been hampered by technical difficulties not previously evident in the mass spectrometer technique and which raise doubts on interpretation of data. Notwithstanding these difficulties, evidence has been obtained which gives cause to question some of the evidence on photorespiration. Other information of interest in connection with photosynthetic transients

has also been collected and will be published shortly. Further studies will be needed to understand the full significance of increased oxygen consumption in the light.

SUPPORTED BY U.S. National Science Foundation

5.0775, BIOSYNTHETIC PROCESSES DURING DEVELOPMENT OF SEA URCHIN EGGS

***R.M. IVERSON*, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124**

The sea urchin egg is a suitable system for investigating the processes occurring during the division stages and early embryogenesis. Large quantities of synchronous cells for studying the biochemical and physiological events concerned with mitosis and development of the organism can be obtained and embryos can develop to the blastula stage in the absence of m-RNA synthesis, at which time new m-RNA must be synthesized for continued development.

This raises the question of how the oocyte stores cellular components, for example, the m-RNA during oogenesis, activates it upon fertilization, controls its function at the translational level during early embryogenesis, and initiates at the blastulagastrula stage new m-RNA synthesis and integrates its function with the m-RNA stored by the oocyte.

Our investigations are concerned with: (1) the appearance and characterization of the polysomes after fertilization and during early embryogenesis; (2) the activation and integration of function of the m-RNA stored in the oocyte with that synthesized at the blastula gastrula stage (do they have different 'classes' of ribosomes associated with them?), and whether they are encoded for similar proteins; (3) the characterization of selected proteins formed by the polysomes at selected developmental stages; and (4) the basis for the difference in the 105,000xg supernatants obtained from fertilized and unfertilized eggs to support in vitro protein synthesis.

SUPPORTED BY U.S. National Science Foundation

5.0776, CHEMISTRY AND BIOLOGY OF SOME COELENTERATE NEMATOCYSTS

***H.M. LENHOFF*, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124**

The coelenterate nematocyst continues to intrigue biologists. The nematocyst, one of the most complex specialized intracellular structures known, is essentially a capsule containing an inverted thread retained by a closed operculum. When the nematocyst is stimulated to discharge, the operculum opens and the thread everts. Depending upon the type of nematocyst, the everted thread may either pierce the prey and inject a toxin, lasso bristles on the prey, or adhere to adjacent surfaces. Investigations are planned to identify the chemical composition and physical properties of purified nematocyst capsules, and to purify the toxin and study the mechanism of its action. Information obtained from these studies, will be used to investigate the synthesis to their eventual site of action, and their mechanism of discharge.

SUPPORTED BY U.S. National Science Foundation

5.0777, EXPERIMENTAL STUDIES ON THE BIOLOGY AND FOOD CHAIN ECONOMICS OF THE CHAETOGNATHS

***M.R. REEVE*, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124**

The objective of this study is to advance our knowledge of the biology and physiology of this very important group of planktonic marine invertebrates, thereby working towards an understanding of their role in the food chain as plankton carnivores. Practical steps being taken to achieve these ends include the initiation of development of laboratory rearing techniques which will allow eggs hatched from mature adults to be reared through their immature stages and complete the cycle. Quantitative aspects of reproduction are being studied including gonad maturation sequence, egg production per brood and number of broods as a function of temperature. Energy budgets are being worked out using Artemia as food in experimental regimes by computing the gross growth efficiency of Sagitta hispida at various stages in its life history and at various temperatures. The budgets are balanced by making measurements also of oxygen consumption, dissolved nitrogenous excretion and faecal pellet production.

SUPPORTED BY U.S. National Science Foundation

5.0778, ECOLOGY OF PHYTOPLANKTON IN SEMI-TROPICAL ENVIRONMENTS

***E.J. WOOD*, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124**

Vertical and horizontal distribution of phytoplankton was related to the hydrographic factors in the Straits of Florida, Northeast and Northwest Providence Channels and the Tongue of the Ocean. It was found possible to relate phytoplankton maxima to isopycnals, and to interpret the peaks in terms of seasonality and depth relationships. The species were found to relate directly to the North Equatorial Current. Papers published as a result of this grant include; E.J.F. Wood, Bull. Mar. Sci. 18, 1-4; 481-543, Vargo, G. Bull. Mar. Sci. 18, 5-60. In addition a further paper on the Autecology of Diatom Species in the Area is in press (Nova Hedwigia) and another on the dinoflagellates and their ecology is in MS.

SUPPORTED BY U.S. National Science Foundation

5.0779, RELATIONSHIPS BETWEEN PHYTOPLANKTON AND ZOOPLANKTON IN THE CARIBBEAN SEA

***E.J. WOOD*, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124**

The phytoplankton of the Caribbean appears to be derived in the main from the North Equatorial Current, though contributions are made from the neritic communities along the coasts of Venezuela and Brazil, from the islands of the West Indies, and from the shallow banks in the Honduras region such as Gorda Bank and Arrowsmith Bank. The micro-- algae from these areas, including many species of benthic and epontic diatoms, usually enter the water at depths of 50 to 100 meters. A further contribution comes from the Sargassum which forms a large part, possibly at times the major part of the plant biomass of the Caribbean Sea. This contribution includes benthic and epiphytic species of diatoms and flagellates, which may also form as great a biomass as the true phytoplankton. The effect of upwelling to the east of the West Indies has been shown in the phytoplankton populations. Work on the western end of the Caribbean was not completed at the conclusion of the grant.

SUPPORTED BY U.S. National Science Foundation

5.0780, RED TIDE TOXICITY

***J.E. SYKES*, U.S. Dept. of Interior, Biological Laboratory, *Saint Petersburg - St. Pt. Bc., Florida* 33706**

This research is concerned with biochemical aspects of Gymnodinium breve; specifically the isolation and characterization of its toxin. Phase one includes development of growth of the organism; Phase two- efforts to fractionate the toxin initially by analytical chromatography and later through use of preparative gas chromatography. Phase three will incude a more detailed study of the chemical and physiological properties.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0781, THE OCCURRENCE AND EFFECTS OF PLANKTON IN THE SEA

***A.W. COLLIER*, Florida State University, Graduate School, *Tallahassee, Florida* 32306 (NONR)**

The investigator is analyzing the chemical and physical characteristics of the metabolites of planktonic organisms under natural conditions, as well as in the laboratory under special environmental conditions in defined media. He is continuing his studies of the ultra-plankton organisms he discovered recently to determine their contribution to the physical and chemical properties of the air-sea interface and upper oceanic layers.

Hydrobiological studies have been contributing a large store of knowledge concerning the inhabitants of the sea and the effects

of the environment upon them. In the development of these studies, the more or less subtle ways in which the organisms effect the environment are coming under examination. The effects are particularly notable in the minute, but extremely abundant planktonic forms which are being shown to be causative factors in many problems connected with the installation, maintenance, and performance of underwater equipment.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0782, MICROBIAL ACTIVITY IN NON AQUEOUS SYSTEMS

C.H. OPPENHEIMER, Florida State University, Graduate School, *Tallahassee, Florida* 32306

A study of the growth and distribution of microorganisms that preferentially live in oil. Experiments will provide information on water availability in the non-aqueous oil environment. Growth rates of selected microbes will be measured.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

5.0783, RESEARCH ON THE ROLE OF BACTERIA IN THE OCEAN

W.J. PAYNE, Univ. of Georgia, Graduate School, *Athens, Georgia* 30602 (NONR)

Objective: Some marine bacteria are responsible for the process of dentrification whereby nitrogen is lost from the environment in the form of nitrogen or ammonia. This terminal year of research is to determine what specific bacteria and chemical events lead to this undesirable process and subsequent loss of valuable nitrogen for marine and animal use.

Approach: An effort will be made to characterize the specific bacteria, the enzyme system, and electron transport mechanisms involved in denitrification. A comparison of marine and terrestrial bacterial species will be made to determine fundamental differences in denitrification metabolism in the two types.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0784, PHYSIOLOGICAL CHARACTERIZATION OF CERTAIN MARINE BACTERIA

N.W. WALLS, Georgia Inst. of Technology, Engineering Experiment Station, *Atlanta, Georgia* 30332

The objectives of this research project were: (1) to isolate in pure culture the microorganisms contained as a mixed flora in certain ocean sediments material; (2) to lyophilize these and other bacteria collected in the field to preserve them for future study; and (3) to morphologically and biochemically characterize certain of the species.

SUPPORTED BY Georgia Institute of Technology

5.0785, DIVERSITY, COMMUNITY STRUCTURE AND TROPHIC RELATIONS OF TROPICAL ZOOPLANKTON

R.I. CLUTTER, Univ. of Hawaii, Graduate School, *Honolulu, Hawaii* 96822

The research project involves sampling and analysis of plankton communities, in a tropical bay (Kaneohe Bay, Oahu) and in the open sea.

Assessment of standing stocks and species diversity is being done in the bay as a whole. Two subregions have been chosen that are similar in general species composition but have different standing stocks and different indexes of diversity. In these subregions an attempt will be made to determine trophic relationships and energy pathways among the major species.

With the background experience gained in the bay, it is expected that future work will include vertical distribution and energy exchange problems in the open tropical Pacific. Field equipment is being readied for this purpose.

SUPPORTED BY U.S. National Science Foundation

5.0786, DEVELOPMENT AND EVALUATION OF A NEW TECHNIQUE FOR SAMPLING ZOOPLANKTON

G.I. MURPHY, Univ. of Hawaii, Hawaii Inst. of Marine Biology, *Honolulu, Hawaii* 96822

It is proposed to construct, test, and do preliminary experiments with a radical innovation in zooplankton sampling, a plankton purse seine. If successful, this technique should yield absolute calibration of conventional equipment, new insight into distribution, and a more meaningful approach to zooplankton community dynamics.

SUPPORTED BY U.S. National Science Foundation

5.0787, ISOLATION AND TAXONOMY OF YEASTS IN LAKES AND SEWAGE

L.R. HEDRICK, Illinois Institute of Technol. , Graduate School, *Chicago, Illinois* 60616

To date, 13 different sites in the Calumet River area on the Illinois-Indiana border have been sampled for yeasts. The two genera most often encountered were Candida and Rhodotorula. In an effort to determine just what aspects of pollution were affecting the yeast population, data on chemical and physical pollution indicators were fed along with the numbers of yeasts into an IBM 360 computer. At every station, it was found that two parameters which gave the highest regression values were the nitrite-nitrate nitrogen and dissolved oxygen content of the water.

Currently, a survey of changes in yeast populations with the seasons is being conducted. The following pathogenic yeasts have been isolated: Cryptococcus neoformans, Torulopsis glabrata, Candida tropicalis, Candida Parapsilosis, and Trichosporon cutaneum.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0788, ULTRASTRUCTURAL AND AUTORADIOGRAPHIC INVESTIGATION OF CALCIFICATION IN FORAMINIFERS

W.W. HAY, Univ. of Illinois, School of Engineering, *Urbana, Illinois*

This proposal is to extend a study of calcification in foraminifers already underway (NSF GB-4101). It has been possible to establish viable cultures of a wide variety of foraminifers, and to induce some species to reproduce and so become convenient subjects for the study of calcification, to perfect a technique for sectioning cytoplasm and test wall intact and to start a survey of cell ultrastructure. A considerable amount of information on the biological ultrastructure of foraminifera is now being gathered, and study of specimens actively calcifying the test is being carried out. The project would extend the study from the species currently being investigated to representatives of other groups, correlate electron microscopic and light microscopic investigations of cytological structures, test a new working hypothesis of the calcification process, and study the pathway of calcium from uptake from the culture medium to implacement in the wall, using autoradiography.

SUPPORTED BY U.S. National Science Foundation

5.0789, ZOOPLANKTON OF THE GULF OF MAINE

K. SHERMAN, U.S. Dept. of Interior, Biological Laboratory, *Boothbay Harbor, Maine* 04538

This research will provide information regarding seasonal and annual changes in zooplankton distribution and abundance in relation to hydrographic conditions. Present effort is centered along the Gulf of Maine coast, from Cape Ann (Mass.) to Machias Bay (Me.), and from inshore to the 50 fathom isobath.

Zooplankton collected from two series of seasonal cruises (winter, fall, summer, and spring) is examined: 1) along-shore coastal cruises (20 stations) using a Gulf III sampler, on 30-minute oblique tows, taken from 20 meters to the surface, 2) inshore-offshore transect cruises from three areas (west, central and eastern gulf). Three stations, spaced at 7.5 mile intervals, are located on each transect. Collections are made with Clarke-Bumpus samplers towed in a series at 0-10-30 and 60 meters depending on bottom topography.

Environmental observations at each station include: 1) Nansen bottle casts at 0-10-20-30-60 meters and bottom, 2) bathythermograph cast, 3) water transparency measurements using secchi disc and photometer, 4) meteorological observations recorded on NODC-BT log format, and 5) sea bed drifters and drift bottle releases.

The along-shore and inshore-offshore station collections are planned to extend over a two-year period. The 1963 along-shore zooplankton data has been analyzed for relative abundance, group and species (copepods only) composition and areal distribution.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0790, MICROBIOLOGY OF MARINE AND ESTUARINE INVERTEBRATES

R.R. COLWELL, U.S. Dept. of Interior, Biological Laboratory, *Oxford, Maryland*

A study of the natural bacterial flora of oysters and associated invertebrate animals has been initiated. Animals from specified areas of Chesapeake Bay and off the Atlantic Coast are being sampled, using specified aseptic techniques to determine the quantitative and qualitative bacteriological flora of the animals. The normal commensal flora of oysters is being determined by examination of the shell liquor, body flesh, and intestine.

Standard bacteriological procedures are being followed for sampling, testing, and analysis. However, newer techniques of diagnosis and taxonomy will be applied, including the high-speed computer methods and the nucleic acid analyses, techniques developed and/or adapted by the Principal Investigator in previous published research.

Ancillary studies of the environment of the animals, i.e., water and mud samples, are also being undertaken. Unique features of the bacterial populations which are observed will be studied in detail.

The work is being undertaken at Georgetown University with the active collaboration of personnel at the Biological Laboratory, Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service, Oxford, Maryland.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0791, COMPARATIVE BIOCHEMICAL AND MORPHOLOGICAL CHARACTERISTICS OF MARINE FUNGI FROM SHELLFISH

S. GOLDSTEIN, U.S. Dept. of Interior, Biological Laboratory, *Oxford, Maryland*

Appropriate histological, histochemical, and cultural methods are used to determine the presence of fungal parasites in shellfish. With the use of conventional and laboratory prepared and modified media, isolations and clones are made of the fungi present in tissues. Physical and physiological parameters necessary for the growth and reproduction of the organisms isolated are established. Morphological properties and nutritional requirements of the isolates grown in vitro are described. Appropriate chemical and biochemical analyses are carried out on the isolates and supporting media so as to permit adequate characterization, possible identification, and to establish the taxonomic position of the isolates. The work is being undertaken at Brooklyn College.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0792, MORPHOGENESIS OF THE BACTERIOPHAGE

M.B. BAYLOR, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

We are working on the interactions of genes that control the architectural proteins in the mature coliphage. We believe we have markers for these genes and thereby will be able to locate genes controlling different proteins in the same structure and also genes, the products of which, modify the final functional structure.

We have established by four very different approaches that one group of genes in which our mutants occur, control tail structure not including tail fibres. Our methods included phage morphology as revealed by the electron microscope, in vitro assembly of T2-T4 hybrids, genetic homologies between T2 and T4 and examination of purified solubilized sheath by gel electrophoresis. However, we have found a mutant, not in this region, which also affects both sheath morphology and the pattern of the band on the gel. Our results led us to suggest that at least two, and probably more, proteins are contained in the sheath. More are concerned with sheath morphopoiesis.

We intend to study the sheath components by several physical chemical techniques. We believe we have also a label, through our mutants, on other tail structures such as face plate and tube.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0793, A STUDY OF THE ECOLOGY OF THE MICROFAUNA LIVING BETWEEN INTERTIDAL MARINE SEDIMENTS

D.J. ZINN, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

The work is directed toward studying ecologically and taxonomically the fauna belonging to the mesopsammic biotope environmentally represented by the various kinds of intertidal substrata that make up the beaches of the New England Coast. The main effort is to collect and interpret information on the psammon of the area. Representative beaches along the shores of Connecticut, Rhode Island, Massachusetts, New Hampshire and Maine will be sampled. In addition to quantitative and insofar as possible, qualitative determinations of the faunal groups comprising each biocoenose, attention will be paid to the interstitial milieu and the lacunar spaces between the sand grains, in whose water films the mosopsammic animals live, in terms of grain size, beach slope, temperature, salinity, oxygen, pH, tidal factors, meteorological and hydrological conditions, and so on. Faunal analysis will emphasize the mystacocarids and the copepods. As time permits zoogeographical distribution patterns of the dominant forms will be considered by comparison with psammon collections made at convenient locations along southern atlantic coastal beaches of the United States.

SUPPORTED BY U.S. National Science Foundation

5.0794, LANGMUIR CIRCULATION AND PLANKTON ECOLOGY

E.R. BAYLOR, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

The food chain in the ocean depends primarily upon the events occurring in the upper one hundred meters of water. Most of the production of phytoplankton takes place in this stratum. Also, it has been shown by the principal investigator and his associates that in the upper layer of this stratum the naturally occurring suspended and dissolved organic materials in sea water may be concentrated and converted into edible particles used by zooplankton by wave-induced foaming. The work of the principal investigator on patchiness of plankton abundance questions its relation strictly to the hydrodynamic variables of Langmuir circulation. Results have permitted modification of the original theory which needs testing. The predictions to be tested are: when the wind direction is steady for twenty-four hours the plankton abundance is well correlated with the windrows; when a major shift in wind direction occurs, the plankton is patchy but poorly correlated with windrows; when the wind is highly variable in direction for twenty-four hours the spatial distribution of plankton is virtually random.

The purpose of this research is to test a model of air-sea interaction developed by the principal investigator and his associates to explain the plankton distribution and its relation to wind pattern and surface circulation pattern. The model proposes that the horizontal roll vortices of Langmuir circulation in the water are coupled to and driven by larger (1KM) horizontal roll vortices in the air just over the water. In effect, there is simply a large-scale Langmuir circulation in the air driving a smaller-scale Langmuir circulation in the water. A Hardy continuous plankton recorder will be towed to indicate what the Sperry reflectoscope (previous grant) recorded. Kites will be used to hold instruments directly over the plankton collection spots. All data will be subjected to computer analysis. The methods employed should settle many questions concerning plankton ecology, particularly the effect of Langmuir circulation on distribution.

SUPPORTED BY U.S. National Science Foundation

5.0795, RADIOELEMENT STUDIES IN THE OCEANS-PLANKTON DISTRIBUTION STUDIES

V.T. BOWEN, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (AT(30-1))

On samples collected for fallout isotopes measurements, studies are made of the species distribution and relative abundances of Foraminifera, Radiolaria and Acantharia. With few systematic exceptionns, the three groups show covariance rather than opposing abundances. Both Radiolaria and Acantharia prove to be major components of the plankton, and of evidently underestimated geochemical significance. In those water masses lacking one or another of these groups, this should show in form of aberrantly high surface concentrations of the appropriate element. Much of this work is now being prepared for publication.

SUPPORTED BY U.S. Atomic Energy Commission

5.0796, MICROBIAL TRANSFORMATIONS IN SEA WATER

H.W. JANNASCH, Woods Hole Oceanographic Inst. , ***Woods Hole, Massachusetts*** 02543

Studies on the development of reproducible enrichment techniques in continuous culture for the isolation of characteristic marine bacteria were completed. Within a certain range of dilution rates and concentrations of the limiting substrate, chemostat enrichments were successful. Experimental attempts to separate single species from mixed cultures of known composition showed that successful or unsuccessful competition for the limiting substrate could be expressed by kinetic growth parameters of the individual species under given conditions. Species exhibiting low values of their growth parameters displaced species with relatively high values if the continuous culture was operated correspondingly at low dilution rates and/or low concentrations of the limiting substrates. This behavior is significant for the characterization of those micro-orgnisms actually responsible for the degradation of organic materials in the sea under natural conditions.

Based on the determination of growth parameters, the studies on population dynamics were continued. Mixed pure cultures of marine and non-marine bacterial strains were grown in the chemostat at doubling times up to 100 hours and at various concentrations of limiting substrate. Predicted displacement times could be confirmed experimentally.

Techniques for studying sulfate reducing bacteria in steady state culture have been established. The kinetics of substrate- (sulfate) and product- (sulfide) limited growth were studied with the aim of detecting characteristics metabolic differences.

SUPPORTED BY U.S. National Science Foundation

5.0797, STUDIES ON MICROBIAL SULFATE REDUCTION AND SULFIDE OXIDATION IN MARINE ENVIRONMENTS

H.W. JANNASCH, Woods Hole Oceanographic Inst. , ***Woods Hole, Massachusetts*** 02543

Forty-one strains of sulfate-reducing bacteria were isolated from various marine or saline environments including New England estuaries. Continental Shelves (U. S. East Coast and North Sea), the Peru trench, Lake Tiberias/Israel, the Red Sea, and Lake Faro (Sicily). All strains were studied with respect to utilization of significant organic hydrogen donors, salinity requirements, optimum growth temperatures, growth temperature ranges, and resistance to hibitane. Based on these data the strains were classified according to Postgate and Campbell.

Enzyme activities of carbohydrate metabolism in Desulfovibrio were studied under various growth conditions. Chemostat grown cells of various generation times were compared with batch culture grown cells.

SUPPORTED BY U.S. National Science Foundation

5.0798, BIOLOGY AND CHEMISTRY OF MARINE PLANKTON POPULATIONS

B.H. KETCHUM, Woods Hole Oceanographic Inst. , ***Woods Hole, Massachusetts*** 02543

The short term changes which proceed during the growth of plankton populations are to be studied in the Gulf of Maine. A parachute drogue attached to a radio buoy is used to identify a particular patch of water and observations are made close to the buoy. The objectives of this program are to evaluate quantitatively the turnover rates of the nutrients and to study rates of decomposition in situ. It has been postulated that in situ recycling of elements maintains the level of productivity in parts of the world throughout much of the year, but no useful estimates of recycling rates have been available. Additional studies include the changes in the vertical distribution of chlorophyll and the rate of sinking of particles, the changes in the ratio of elements in particles as they sink and decompose in the water column, and diurnal variations in the rate of photosynthesis as a function of the chlorophyll content of the water. Studies of the vertical distribtuion of the zooplankton are included since a substantial part of the regeneration of elements may result from the phytoplankton respiration and zooplankton consumption and digestion of particulate matter in the sea.

SUPPORTED BY U.S. Atomic Energy Commission

5.0799, BIOLOGY AND PALEONTOLOGY OF MARINE DINOFLAGELLATES AND HYSTRICHOSPHERES

D. WALL, Woods Hole Oceanographic Inst. , ***Woods Hole, Massachusetts*** 02543

The life histories of modern thecate dinoflagellates (Dinophyceae) are being investigated with special emphasis on those genera and species that produce resting spores. Such spores are abundant both on the surface sediments of present day seas and as microfossils (variously called fossil dinoflagellates and hystrichospheres) that are preserved in marine sediments of post-Paleozoic age in the main. We are attempting to correlate resting spores with their appropriate motile stage in the life histories of numerous marine and freshwater species by the germination of spores in vitro and unialgal cultures and also to study the biogeographic distribution of spores in surface sediments of the eastern coast of the United States and Caribbean area. Paleontological studies also will be made of the vertical distribution of dinoflagellates in some Late Tertiary and Quaternary marine epicontinental sequences and attempts will be made to relate this distribution to the observed lateral distribution of corresponding cysts in modern sediments.

SUPPORTED BY U.S. National Science Foundation

5.0800, NITRIFICATION BY MARINE MICROORGANISMS

S.W. WATSON, Woods Hole Oceanographic Inst. , ***Woods Hole, Massachusetts*** 02543

This proposal is for the continuation and expansion of our studies on the role nitrifying bacteria play in the ocean and the molecular mechanisms by which these organisms convert, store and utilize energy derived from the oxidation of ammonia or nitrite. The specific objectives include: (1) the isolation and purification of new marine nitrifying bacteria; (2) the determination of the vertical and horizontal activity and distribution of nitrifying bacteria in the open ocean; (3) a morphological study of the fine structures of nitrifying bacteria; (4) a study of the metabolic pathway by which marine nitrifying bacteria oxidize ammonia to nitrite and nitrite to nitrate using cell free systems; (5) an attempt to elucidate the reason or reasons why nitrifying bacteria are obligate autotrophs (6) a study of the role of the submicroscopic cytomembrane systems and other submicroscopic structures observed in Nitrosocystis oceanus, Nitrosomonas europaea and Nitrobacter agilis; (7) a study of the kinetics of nitrification; (8) the development of new cultural techniques.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0801, PLANKTON AND BENTHOS COMMUNITIES OF THE GREAT LAKES

J.F. CARR, U.S. Dept. of Interior, Biological Laboratory, ***Ann Arbor, Michigan***

The objectives of this project are to determine the plankton and benthos species occurring in the Great Lakes and study their distribution, and seasonal and annual abundance. Plankton and benthos have been sampled on a routine seasonal basis in Lakes Erie and Superior, and during surveys of a Lakes Erie, Huron, Michigan, and Superior. At present, we are concerned primarily with changes in the benthos of Lake Erie, seasonal fluctuations of diatoms in Lake Superior, and determining the sampling efficiencies of the orange-pool, Petersen, and Smith-McIntyre dredges in various sediments and at various depths. Smaller phases of the project involve a study of the Japanese snail Viviparous japonious which has appeared in Sandusky Bay, Lake Erie, and a study of the polychaete Manayunkia species in Lake Erie.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0802, DISTRIBUTION AND ABUNDANCE OF ZOOPLANKTON IN LAKE ERIE

J. REYNOLDS, U.S. Dept. of Interior, Biological Laboratory, *Ann Arbor, Michigan*

This project is aimed at obtaining good estimates of relative abundance and standing crop of common species of zooplankton in Lake Erie, Such estimates require a knowledge of the variation in catch contributed by factors causing other than real changes in biomass (i.e., apparent changes due to sampling). Initially, a restricted area in Lake Erie will be sampled to determine the extent of sampling error. Subsequent experiments will attempt to quantify those ecological relationships which significantly mask the real changes in zooplankton abundance. Considering present knowledge of zooplankton ecology, some of the factors studied will be light, oxygen, temperature, diurnal movement, and horizontal distribution. Proper treatment of the data will require multiple regression analysis and multiple analysis of variance using the high-speed computer. Inclusion of any significant ecological factors as an adjustment in estimation would increase the precision involved in detecting real changes in zooplankton abundance. Hopefully, these improved estimates may give additional meaning to the relation between density of zooplankton and survival of certain species of fishes in Lake Erie, particularly young-of-the-year. The project will begin during May 1967.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0803, PLANKTON ECOLOGY

D.C. CHANDLER, Univ. of Michigan, Graduate School, *Ann Arbor, Michigan* (NONR)

This research bears on three related studies. A planktological survey of Lake Michigan has been conducted with especial attention being given to the microcrustacea. Secondly, the aforementioned planktological survey cruise Research Ships of Opportunity was being used to obtain information and experience as to the utility and problem in setting up a continuing RSO program. This project is utilizing the specimens and data gathered in the lake survey sampling, in a study of the seasonal and geographical patterns in the abundance of the several stages in each of the four species of the copepod genus diaptomus.

The gathering of data regarding physical, chemical, and biological parameters of ocean environments is a recognized necessity for the better understanding and prediction of effects of environmental factors on Naval operations. In order to collect adequate information, existing research equipment must be evaluated and new equipment developed. In addition, the technology of positioning the data gathering equipment in preselected geographical areas must be updated. Research Ships of Opportunity offer one means for synoptic oceanographic data collecting systems.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0804, PLANKTON REARING, ENVIRONMENTAL REQUIREMENTS AND SENSITIVITY STUDIES

C.M. TARZWELL, U.S. Dept. of Interior, Natl. Water Quality Lab., *Duluth, Minnesota*

This project is carried out by the Culturing, Production and Sensitivity Studies Unit of the Plankton-Microbiology Section. It has as its purpose the determination of the sensitivity of the more important planktonic organisms to selected materials or wastes. In accomplishing this objective, all planktonic organisms within the upper Great Lakes area will be collected and identified. Those representing a considerable portion of the total population will be cultured. It is anticipated that considerable time and effort will be devoted to this culturing activity. In connection with these activities, life history and requirements will be investigated and studied in some detail. Planktonic organisms of importance in the biota will be reared so that they may be used in short-term bioassay studies to determine the most sensitive species or life stages to a particular material or waste. This will involve the screening species or of wastes using a large number of different planktonic organisms. The species and life stage found to be most sensitive to the particular material or waste in question will then be used by another unit in studies to determine the long-term effects and the levels of a potential toxicant which are not harmful to the organism. This project was started in Fiscal Year 1967 and is a continuing activity.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0805, THE ROLE OF SULFUR BACTERIA IN CORROSION AND DETERIORATION

G.E. JONES, Univ. of New Hampshire, Graduate School, *Durham, New Hampshire* 03824

Objective: This task will assist the Navy in understanding the role of sulfur bacteria in the oceanic environment. Sulfur is relatively plentiful in the ocean, and its utilization by microorganisms contributes to corrosion and deterioration of structure materials.

Approach: Marine sulfur-oxidizing bacteria possess a membrane which appears to be the site at which sulfur oxidation takes place. The membrane will be harvested in quantity and examined for chemical composition and sulfur oxidizing activity.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0806, A STUDY OF THE ICHTHYOPLANKTON ASSOCIATED WITH TWO OF NEW JERSEYS COASTAL INLETS

W.S. MURAWSKI, State Div. of Fish & Game, *Trenton, New Jersey*

A. Objectives: To determine the species of fish which are found in our lower estuaries as eggs and/or larvae. To further determine at what time of year their occurrence takes place, for what duration of time, and under what salinity and temperature conditions. Information of this nature is very valuable in our biological appraisal of this area of the estuary, especially in regard to any proposed man- made changes in the environment.

B. Procedure: Weekly ichthyoplankton samples will be made year round at Manasquan and Corson Inlets. At the former station, the net will be fished from a bulkhead that runs parallel to the tide; and at the latter station, the net will be fished from the center of a low bridge that spans a branch of the inlet. In each case, the nets will be held stationary in a flooding tide. The nets used will be one-meter in diameter and will be fished in the surface waters for one hour during periods of darkness. Flowmeters will be used to determine the volume and velocity of the water sampled. Observations of the physical environment will include temperature and salinity.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
New Jersey State Government

5.0807, BIOLOGICAL OCEANOGRAPHY & DETERIORATION - SHALLOW WATER MARINE SEDIMENTS & WATER COLUMN BACTERIA

E.C. FISCHER, U.S. Navy, Applied Sciences Lab. , *Brooklyn, New York* 11251

Objective: To investigate biological problems associated with shallow continental shelf waters and to relate turbidity to microbiological content particularly directly over the sea floor.

Approach: Develop instrumentation package for concomitant turbidity and bacteriological analysis of continental shelf waters from surface to sea floor. Conduct at-sea measurements within local waters. Perform bacteriological and gross particulate analysis of samples.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0808, EXPERIMENTAL ECOLOGY OF LOWER MARINE FUNGI

S. GOLDSTEIN, City University of New York, Graduate School, *Brooklyn - Brooklyn College, New York* 11210

Comparative development and physiology of nonfilamentous zoosporic phycomycetes isolated from polluted littoral habitats.

SUPPORTED BY City University of New York

5.0809, A NEW APPROACH TO NUTRITION, PHYSIOLOGY, AND MINERAL CYCLING OF FORAMINIFERA

J.J. LEE, Amer. Museum of Nat. History, *New York, New York* (AT(30-1))

We are continuing our studies of the foraminifera, a biologically poorly known group of microorganisms which is important in marine biogeochemical cycling. Priority has been given to the establishment of gnotobiotic dependable laboratory cultures for use in experiments. Tracer technique will be used to identify food organisms. Reduction of non-growth promoting organisms from agnotobiotic cultures and aseptic technique should lead to vigorous synxenic cultures with fewest associated foof organisms.

We will study the microbial flora and fauna of natural littoral foraminiferan bloom areas and the physiological ecology of prominent members of the community that can be isolated in axenic culture. The results of the foregoing studies, correlated with energy-flow experiments and experimental manipulation of model microcosms, should assist in the interpretation of the nonrandom distribution of foraminifera in nature and the conditions favorable to the bloom of certain species. This work will be of interdisciplinary value in marine productivity and paleoecology.

SUPPORTED BY U.S. Atomic Energy Commission

5.0810, MECHANISMS OF ATTACHMENT OF MARINE BACTERIA TO SURFACES

W.A. CORPE, Columbia University, Undergraduate School, *New York, New York* 10027 (N00014-68-A-0225-0001)

Objective: This research concerns microorganisms which grow on marine surfaces and are involved in fouling and corrosion. This effort will assist the Navy in developing procedures and methods for producing surfaces which possess antifouling and anticorrosion properties.

Approach: The growth of microorganisms on marine surfaces may effect the subsquent growth and development of higher forms of plant and animal life. Deterioration of surfaces exposed to the marine environment by molluscs, crustaceans, and other life is usually preceded by microbial growth. This effort is being devoted to the examination of kinds and characteristics of film-forming bacteria.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0811, MICROBIOLOGICAL ASSAYS OF SEAWATER USING RADIOISOTOPES

K. GOLD, New York Zoological Society, *New York, New York*

Objectives: 1) To study the role of vitamins in the ecology of marine primary producers, with special emphasis on thiamine in sea water. 2) To isolate marine planktonic ciliates and other ecologically important phagotrophic and heterotrophic protozoa for studies of protozoan - phytoplankton relationships - a primary link in the marine food chain.

It was determined previously that thiamine was rapidly destroyed in sea water at temperatures greater than 30 degrees C and less rapidly at 20 degrees C. Thiamine destruction can be prevented, however, if various organic compounds are added to thiamine-enriched sea water before incubation at destructive temperatures. Among the compounds tested naturally occuring amino acids, nucleotides and citric acid were the most effective protectants. Since these or related compounds may also play the same role in nature, it is of interest to know the mechanism of protection, and, therefore, one objective of this program is to pursue this study further.

A representative of the ciliate order Tintinnopsis was isolated and has been maintained in vitro since June, 1966. Tintinnids are the most abundant and diverse ciliates found in the marine environment; they are the only ciliates found in the fossil record. Since they are voracious feeders, agglutimate particulate material to their loricae and have a rapid diversion rate, these protozoa appear to be important micro-consumers of primary producers. Their role will be evaluated by in vitro feedings studies.

SUPPORTED BY U.S. Atomic Energy Commission

5.0812, ECOLOGY OF PLANKTONIC FORAMINIFERA AND RELATED STUDIES

A.W. BE, Columbia University, Graduate School, *Palisades, New York* 10964

Geographic, vertical and seasonal distributions of shell-bearing plankton groups (Foraminifera, Coccolithophoridae and Pteropoda), based on global plankton collection obtained on board R/V Vema and Robert Conrad.

The objective is to delineate the distributional patterns of individual species in the light of such environmental factors as temperature, salinity, depth, nutrients and food. This ecological information can be used for interpreting ancient environmental conditions during which fossil assemblages (now entombed in deep-sea sediments) had lived. Multivariate statistical analysis is used to determine coefficients of proportional similarity among the many species in order to discriminate natural species groupings.

The shell microstructures of planktonic Foraminifera and Pteropoda are being examined by transmission and scanning electron microscopy and internal shell morphology is investigated by means of an X-ray projection microscope.

Research and development of plankton sampling gear is being continued to study sampling reliability.

SUPPORTED BY U.S. National Science Foundation

5.0813, C-14 UPTAKE, LIMITING FACTORS AND EXCRETION PRODUCTS OF ANTARCTIC PHYTOPLANKTON

P.R. BURKHOLDER, Columbia University, Graduate School, *Palisades, New York* 10964 (AT(30-1)3849)

With 14C techniques the assimilation and excretion of carbon by marine phytoplankton will be studied in relation to light, trace elements, phosphate, nitrate, and age of plankton blooms in waters adjacent to the Antarctic Peninsula. Effects of experimental enrichment of water samples upon the rate of carbon assimilation will be studied in the Gerlache Strait and the Drake Passage. It is hoped to obtain information that will help to explain variations in productivity in neritic and oceanic areas and the great differences that have been observed in assimilating numbers in different Antarctic areas and seasons.

SUPPORTED BY U.S. Atomic Energy Commission

5.0814, PHOTOSYNTHETIC BACTERIA

E.H. BATTLEY, State University of New York, Graduate School, *Stony Brook, New York* 11790

This investigation is concerned with the isolation in pure culture and characterization of representative types of photosynthetic marine sulfur bacteria. Special instruments for precision measurement of the temperature, pH, and osmotic optima for growth have been developed as valuable aids in the classification process.

This task represents an additional effort in the current program in marine microbiology. The proposed studies will be devoted to the development of stable and reliable criteria for the characterization of photosynthetic sulfur bacteria, a group of organisms commonly found in marine estuaries. These organisms occupy a unique position biologically. Comparatively little is known about them due to difficulties in isolation and cultivation in pure culture. The principal investigator has successfully isolated a large number of strains, however, and has successfully developed criteria for their characterization. The information gained from this task will add materially to our knowledge of the photosynthetic sulfur bacteria and their relationship to the marine environment.

SUPPORTED BY U.S. Dept. of Defense - Navy

5. LIVING SYSTEMS (NON-HUMAN)

5.0815, SYSTEMATICS OF ANTARCTIC HYMENOSTOMATIDA (PROTOZOA)

J.C. THOMPSON, Queens College, Undergraduate School, *Charlotte, North Carolina* 28207

Queens College will conduct a survey of the ciliate order of Hymenostomatida in Antarctica. The principle interest is in the freshwater and marine species of this order of Protozoa but, in addition to aquatic habitats, the principle investigator proposes surveys of available moss and lichen vegetation for obtaining collections of related groups. Living material will be studied in the field, using phase microscopy and recording observations on 16 mm phase movie film. Cultures prepared in the field will be used for selecting material for fixing and staining permanent mounts for the work at Queens College and for exchange material. Field observations will include information on life cycles, food, cysts, conjugation and characteristics of habitats. Special techniques developed by the principal investigator will be applied in the development of the systematic studies on nuclear and subpellicular bodies and fibrillar systems of hymenostome ciliates.

The work will be conducted by the principal investigator and a graduate assistant at Palmer Station.

SUPPORTED BY U.S. National Science Foundation

5.0816, PLANKTON ECOLOGY OF BAR-BUILT ESTUARIES

W.J. WOODS, Univ. of North Carolina, Institute of Marine Science, *Morehead City, North Carolina* 28557

Studies of zoo- and phytoplankton populations have been conducted for several years in Bogue Sound and Pamlico Sound, North Carolina. In addition to periodic samples of the populations, water samples are analyzed for salinity, dissolved oxygen, nitrate, nitrite, ammonia and total nitrogen, and phosphate and total phosphorus. Primary production measurements (phytoplankton) are made routinely with nutrient enrichment.

A phase just starting will attempt to evaluate the contribution of the benthic flora to the production of the sounds.

SUPPORTED BY University of North Carolina

5.0817, STUDIES OF THE AEROCOCCUS-PEDIOCOCCUS BACTERIA

J.B. EVANS, Univ. of North Carolina, School of Agriculture, *Raleigh, North Carolina* 27600

It is proposed to investigate the occurrence, general physiological activities, DNA base ratios and DNA homology of this group of bacteria. The organisms under primary consideration are Gram-positive cocci that tend to produce tetrads in suitable broth media, produce little or no catalase, generally produce greening on blood agar, and ferment glucose much less vigorously than do the lactic acid group of bacteria.

One of the initial phases of this program is concerned with the incidence of these organisms in the hospital environment and the means of differentiating them from the other Gram-positive cocci that are also found there. The physiological studies will be particularly concerned with the pathways of energy metabolism of these organisms. The DNA studies will seek to establish the basic genetic and taxonomic relationships within this group of bacteria.

SUPPORTED BY U.S. Dept. of Hlth. Ed. &,Wel. - P.H.S.

5.0818, DEGRADATION OF MARINE SURFACES BY SALT REQUIRING BACTERIA

I.E. DUNDAS, Univ. I Bergen, *Bergen, Norway* (F61052-67-C-0085)

The objectives of this research are to determine the biochemical, metabolic and genetic properties of some extreme, obligate halophilic (salt-requiring) microorganisms. This will include an investigation of the significance of unique satellite desoxyribonucleic acid (DNA) found in halobacteria. Strains of microorganisms will be isolated from solar salt (salt produced from sea water by solar evaporation). These strains will be further selected by treatment with penicillin since halophiles have been shown to be sensitive to this drug. In this manner mutants will be produced auxotrophic for the various intermediates in the metabolic pathway, permitting a study of the regulatory mechanisms involved. The presence of two species of DNA in a single bacterial strain seems to be characteristic only of the halobacteria. Using standard techniques, the investigator will attempt to discover which fractions of RNA are able to hybridize with the two species of DNA.

The study of extreme halophilics will lead to a better understanding of marine microorganisms, which are important as geochemical catalysts, as links in the food chains leading to commerically important fish, and as fouling and corrosive agents on ships and structures in the water.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0819, THE ECOLOGIC IMPACT OF THE INTERACTIONS AMONG MICROORGANISMS AND AQUATIC CONTAMINANTS IN LAKE ERIE

R.M. PFISTER, Ohio State University, Graduate School, *Columbus, Ohio* 43210

Particulate matter in Lake Erie water will be examined on a physical, chemical, and biological basis, and this matter will be characterized using density gradient centrifugation, electron microscopy, and certain chemical analyses. Microbial portions of the Lake Erie ecosystem will be characterized on the basis of physiological types (not identification). Primary productivity, chlorophyll distribution and photosynthesis-pigment relationships will be examined to obtain information pertinent to particulate and bacterial interactions. Algae will be collected and treated to remove physically associated bacteria. Cultures of bacteria obtained from the algae will be examined in the same manner (e.g., determine physiological types) as the non-algal associated bacteria in water. Surface tension and water content of selected chemicals will be experimentally altered to study the effects on microbial populations (physiological types) and on types of particulates found in the water. Data from these experiments will be correlated in an attempt to establish cause-and-effect relationships.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
Ohio State University

5.0820, MODERN FORAMINIFERA OFF OREGON

G.A. FOWLER, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

The object of the proposed study is to make a detailed examination of the foraminifera from the sea floor off the coast of Oregon. This is an almost unexplored area from the standpoint of foraminiferal ecology. Findings are expanding and augmenting existing knowledge from this and other parts of the world. Results of current investigations demonstrate considerable variation in data from three discrete samples at each station and between closely spaced profiles in the shelf. It is important to determine to what extent the variance of faunal trends occurs. Sufficient samples for this have been obtained already and are partially processed. One year is needed to complete the study.

SUPPORTED BY U.S. National Science Foundation

5.0821, HYDROSTATIC PRESSURE-TEMPERATURE, AS ENVIRONMENTAL PARAMETERS, ON GROWTH, BIOCHEMISTRY AND PHYSIOLOGY OF MICROORGANISMS

R.Y. MORITA, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Objective - a. Problem: The study of metabolic processes under the environmental extremes of temperatures near 0 degrees C and between 50 and 100 degrees C under hydrostatic pressure. b. Application: To determine whether the maximum growth temperature (at 1 atm.) can be elevated by manipulation of hydrostatic pressure and temperature. c. Specifically, interpretations of growth processes will be made at the molecular level to determine the general and specific mechanisms through which temperature-pressure interaction influences or controls these reactions.

Approach - Pressure between 1 and 1,100 atmospheres (17,600 psi.) and temperatures near 0 degrees C and 50 to 100 degrees C will be employed. In vitro studies concerned with the molecular volume and conformational changes of hot and cold marine microorganisms will furnish data concerned with the precise concept and mechanism of the pressure-temperature interrelationship that can happen in vivo.

Progress - a. 30 04 67 to 01 05 68 b. Research indicates generally that microorganisms (terrestrial and marine) coming from environments close to 1 atm. cannot tolerate pressures greater than 600 atm. Certain organisms have been isolated from deep sea environment but in the laboratory have not been shown to withstand elevated pressures from where they were isolated. Three types of organisms have been categorized according to their pressure sensitivity: 1) Cultures able to survive 4 weeks at 1,100 atmos. 2) Cultures able to survive 1 week at 1,100 atmos. 3) Cultures not able to survive 1 week at 1,100 atmos.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

5.0822, DISTRIBUTION OF CL. BOTULINUM E. IN FISH, SHELLFISH AND THE AQUATIC ENVIRONMENT IN OREGON

K.S. PILCHER, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

Objectives are (1) to survey the distribution of this organism as indicated above by appropriate cultural methods; (2) investigate the non-toxic variant strains of the organism to determine whether reversion to toxicity may occur.

SUPPORTED BY Oregon State Government

5.0823, ENERGY AND ELEMENT TRANSFER IN LOWER MARINE TROPHIC LEVELS

L.F. SMALL, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

We have been estimating energy and element transfer in marine phytoplankton and zooplankton. Energy flow in terms of organic matter assimilated by phytoplankton under different environmental conditions in the field, and the utilization of phytoplankton 'energy' by selected important grazers off the Oregon coast is being measured. Estimation of energy inputs and outputs, as well as standing stock of energy, is done in calories, carbon, and ash-free dry weight. We are initiating studies on nitrogen and major molecular constituents (proteins, carbohydrates, lipids) as other indices of energy (organic matter) transfer. We hope this year to get field measurements in an already selected marine environment characterized by single-species phytoplankton successional blooms and one period of intense grazing by a few copepod species. To our knowledge, this will be a first attempt to use essentially laboratory 'energy flow' approaches in a field situation pre-selected for its simplicity to test the approaches.

SUPPORTED BY No Formal Support Reported

5.0824, MARINE BACTERIAL ENZYMES

J.R. MERKEL, Lehigh University, Marine Science Center, *Bethlehem, Pennsylvania* 18015 (NONR)

This research is concerned with the isolation and characterization of marine bacteria in an effort to determine the influence of physical and chemical factors on their growth and enzyme production. Current emphasis is being placed on studies of their protcolytic enzyme production by these bacteria. A technique involving the separation of protein components by ammonium sulfate is being employed for the identification of the enzymes in mixtures found in culture media. Another phase of this program deals with the distribution of proteolytic bacteria in various marine localities.

This investigation is important to the Navy in yielding useful information concerning the role of bacteria and bacterial processes in the sea.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0825, DYNAMICS OF OCEANIC PLANKTON

W.H. SUTCLIFFE, Lehigh University, Graduate School, *Bethlehem, Pennsylvania* 18015

Preliminary experiments have shown that the concentration of ribonucleic acid in some small marine animals may be used as a measure of growth or 'productivity'. Attempts are now being made to apply the method to marine zooplankton.

SUPPORTED BY U.S. National Science Foundation

5.0826, THE CHARACTERISTICS, MECHANISMS AND BIOGEOCHEMICAL CONSEQUENCES OF PHYTOPLANKTON FLOTATION

T.J. SMAYDA, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

The characteristics, mechanisms and biogeochemical consequences of phytoplankton flotation will be determined experimentally. The influence of cell size, chain type and colony size, culture age, silicon and fat content on sinking rates will be investigated. The influence of organic substance liberation and the ensuring changes in viscosity, and the role of viscosity in flotation will be examined. The influence of nutrients and light on sinking rates, as well as the Gross and Zeuthen theory of flotation will also be examined. If time permits, the influence of sinking on the liberation of dissolved organic matter and on the formation of organic aggregates will also be determined.

SUPPORTED BY U.S. National Science Foundation

5.0827, MULTIVARIATE ANALYSIS OF MICROPALEONTOLOGICAL DATA FROM DEEP-SEA CORES

J. IMBRIE, Brown University, Graduate School, *Providence, Rhode Island* 02912

Research initiated under NSF grant GP-4994 on fossilized microorganisms from deep-sea cores will be continued using multivariate analysis of paleontological data as a foundation for geological interpretation. Fossilized microorganisms provide an improtant basis for historical interpretation in geology and climatology and contribute to our knowledge of submarine processes of erosion, transport, and deposition; but to date few investigations involving mathemetical treatment of micropaleontological data have been undertaken. In view of the complexity of distribution patterns, both in organsism and sediments, which result from an interplay of geologic processes and ecological controls, it is especially desirable that mathematical bases for interpretation of the geologic record be improved. It is hoped that multivariate methods may prove helpful in extracting clear, reproducible patterns from complex data, and that these patterns will in turn be of maximum benefit in the interpretation of the geologic record.

Specific objectives of the continued research are: 1) to extend the analysis to depths where previously published analyses show conflicts between temperatures inferred from G. menardii and from oxygen isotope data; 2) to determine how many components are needed to describe foraminiferal communities in Atlantic cores, and if possible to interpret the components ecologically; 3) to attempt to derive a mathematical relationship between isotopic temparatures and quantitative data on planktonic foraminifera.

SUPPORTED BY U.S. National Science Foundation

5.0828, ELUCIDATION OF THE METABOLIC PATHWAYS OF MARINE PLANKTONIC ORGANISMS

T.E. MALONEY, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab., *Wakefield - Kingston, Rhode Island* 02881

This study is concerned with demonstrating the individual physiological processes concerned with the overall metabolism of marine planktonic organisms. This includes investigation of the various enzyme systems of these organisms and demonstrating the mechanisms of these systems with respect to enzyme concentration, substrate concen- trations, pH, temperature, and coenzymes. Also included are investigations to determine the cell fractions or particulates with which the various enzyme systems are associated and the isolation and purification of the enzymes.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0829, EFFECT OF NITRILOTRIACETIC ACID (NTA) UPON THE TOXICITY OF METALS TO SELECTED SPECIES OF ESTUARINE PHYTOPLANKTON

S.J. ERICKSON, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab., *West Kingston, Rhode Island* 02892

Laboratory studies will be conducted to determine the relationship of nitrilotriacetic acid (NTA), a metal chelator, to the toxicity of metals to selected species of estuarine phytoplankton. The metals employed in this study will be those which are known metabolic toxins and are of importance from the standpoint of estuarine pollution.

The toxicity of the various metals to six species of phytoplankton will be determined in the presence of several concentrations of NTA. In addition to growth rate, C14 labeled carbon dioxide will also be employed as a parameter for determining levels of metal toxicity.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0830, EFFECTS OF PETROLEUM AND PETROLEUM WASTES UPON IMPORTANT SPECIES OF ESTUARINE PHYTOPLANKTON AND ZOOPLANKTON

J.H. GENTILE, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab., *West Kingston, Rhode Island* 02892

The effects of petroleum and petroleum wastes upon important species of estuarine phytoplankton and zooplankton will be assessed. Assays on zooplankton will employ acute toxicity to various stages in the organisms' life history as the principal parameters. Assays on phytoplankton will involve the effects of pollutants on growth, photosynthesis, and respiration as well as mechanical effects such as cell lysis. Comparative toxicity of different types of petroleum products will be investigated.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0831, INTEGRATED FIELD AND LABORATORY SYSTEM FOR ASSAYING THE EFFECTS OF POLLUTANTS AND TOXICANTS UPON WATER QUALITY

J.H. GENTILE, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab., *West Kingston, Rhode Island* 02892

The purpose of this project is to investigate the effects of pollutants and toxicants on natural populations of marine phytoplankton as well as on axenic cultures of selected species comprising these populations. Assays will be performed in natural and defined seawaters in such combinations as to obtain a continuum of responses. Laboratory cultures will be designed to simulate field condtions. Measurement of photosynthesis and respiration rates using radioactive carbon will be the principal technique employed and will be correlated with long- term growth studies.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0832, USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS

T.E. MALONEY, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab., *West Kingston, Rhode Island* 02892

This project is concerned with the development of bioassay methods and techniques, employing various species of marine phytoplankton and zooplankton, for determining the toxicity and identity of pollutants in the marine environment and for determining and predicting the short- and long-term effects of lethal and sublethal concentrations of pollutants upon planktonic organisms and other organisms in the marine environment.

The test species will include those which are ecologically important and, in the case of zooplankton, their various life stages.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0833, DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT MARINE PHYTOPLANKTON SPECIES

J.C. PRAGER, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab., *West Kingston, Rhode Island* 02892

Studies have been initited to determine minima, optima, and maxima of selected physical and chemical requirements of four ecologically and economically improtant species of unicellular marine algae. Requirements considered in this program are nitrogen, phosphorus, sulfur, and silicon; also temperature, light, major cations, and redox. Methods used on axenic cultures in synthetic seawater media are growth studies, radioisotopic tracer techniques, chemostatic culture and continuous culture techniques, and various physical mehtods of measuring environmental changes. Species studied are Skeletonema costatum, Olisthodiscus luteus, Nanochloris oculata, and Dunaliella tertiolecta.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0834, DEVELOPMENT OF CULTURE METHODS FOR ECOLOGICALLY IMPORTANT MARINE ZOOPLANKTON SPECIES

E.J. ZILLIOUX, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab., *West Kingston, Rhode Island* 02892

Methods to culture large numbers of individuals of Acartia tonsa, A Clausi, Pseudodiaptomus coronatus, Tisbe furcata, Calanus sp., and Tigriopus californicus are being devised and tested in conjuction with another project concerned with enviornmental requirements of these species. Desiderata are the production of large numbers of individuals in a minimal volume of medium, sucessful completion of life cycles through several generations, elimination of undefined chemical compounds from the medium, simplicity of apparatus, definition of food materials, and ability to operate on a continuous basis.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0835, DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON

E.J. ZILLIOUX, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab., *West Kingston, Rhode Island* 02892

Acartia tonsa, A. clausi, Pseudodiapatomus coronatus, Calanus sp., Tisbe furcata, and Tigropus californicus are undergoing experimentation to determine optimal conditons of temperature, salinity, oxygen saturation, and food materials for sucessful completion of their life cycles. Organisms are cultured and subcultured in the laboratory under small volume, static conditions. End points and condition of cultures are determined by microscopic examination of life cycle progress, in some experiments using time-lapse photography.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0836, STUDIES ON THE DEVELOPMENT OF DERMOCYSTIDIUM MARINUM

J.G. MACKIN, Texas A & M University System, Graduate School, *College Station, Texas* 77843

Studies to date have showed that Dermocystidium marinum Mackin, Owen, and Collier, a parasite of oysters, is a member of the Labyrinthulales, and methods of culture have been developed. Extension of this work aims at study of the developmental cycle in culture, the relations beyond the Labyrinthulales, and application of increased knowledge of epizootiology toward control of the disease in Gulf Coastal estuaries.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0837, LABORATORY STUDIES OF TOXIC DINOFLAGELLATES

S.M. RAY, Texas A & M University System, Graduate School, *College Station, Texas* 77843

Shellfish oysters, clams, and mussels are being subjected to laboratory cultures of Gulf of Mexico dinoflagellates (Gymnodinium breve and Gonyaulax monilata) which are toxic to marine fishes, to determine if these shellfish will produce toxic symptoms when eaten by mammals and birds. We have induced shellfish poisoning in chicks by feeding them oysters which had been subjected to G. breve cultures. The influence of variable culture conditions and media on the relative toxicity of G. breve and G. monilata cultures, and the influence of such factors on the stability of the toxin(s) in shellfish will be investigated. Furthermore, factors that might influence the feeding activity of shellfish subjected to cultures of these dinoflagellates will be considered. Pharmacological and toxicological studies will be conducted to determine the nature and mode of action of the toxins produced by these two dinoflagellates. The purpose of the proposed work is to gather information that will permit the evaluation of the Gulf of Mexico dinoflagellates as potential etiological agents for paralytic shellfish poisoning. Basic information will be obtained on dinoflagellate-mollusc relationships, and thus contribute to our knowledge of ecology and physiology of these two groups of organisms. Other species of Gonyaulax: G. acatenella, G. catenella G. tamarensis, G. polyedra, G. polygramma, G. sphaeroidea, G. spinifera, and G. washingtonensis, will also be studied. The proposed studies are a part of this laboratory's long-range research program in molluscan biology.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0838, BIOLOGICAL OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM)

C.J. GUICE, U.S. Dept. of Interior, Biological Laboratory, *Fort Crockett - Galveston, Texas*

The ecological factors of the ocean environments must be known to make possible the predictions of shrimp productivity. The exact influence of an influx of oceanic water over the continental shelf is not known. To do this, some constant quality of the significant water mass must be measured, and this may be accomplihsed by a grouping of microplanktonic constituents.

Project objectives are to determine (1) the distribution and abundance of plankton species and their association with water masses in the Gulf; (2) which, if any, planktonic organisms are sources of food or predators, or both, for larval and postlarval stages of shrimp and (3) to correlate the distribution and abundance of plankton with physical and chemical properties of Gulf waters and evaluate the use plankton as indicators of significant water masses.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0839, ULTRASTRUCTURAL STUDIES OF PARASITIC AND SAPROPHYTIC FUNGI AND PROTOZOA ASSOCIATED WITH MARINE INVERTEBRATES

F.O. PERKINS, Virginia Inst. of Marine Sci. , *Gloucester Point, Virginia* 23062

The research effort is being directed toward elucidating the fine structure of the following organisms in an attempt to better understand their life cycles and to better understand the host-parasite interactions: Minchinia nelsoni, Minchinia costalis, 'Pepper-crab' disease organism, Labyrinthula sp., Labyrinthomyxa marina.

The taxonomy and phylogenetic relationships of the above protists will be re-evaluated upon completion of this study. Comparisons of the various organelle systems will be made with comparable systems in higher plants and animals.

SUPPORTED BY Virginia State Government

5.0840, A COMPARATIVE SYSTEMATIC INVESTIGATION OF MARINE CILIATES IN THE HOLOTRICHOUS PROTOZOAN ORDER HYMENOSTOMATIDA

J.C. THOMPSON, Hampden Sydney College, Undergraduate School, *Hampden Sydney, Virginia* 23943

The proposed research will involve a comparative systematic study, especially of the somatic and buccal ciliature, of marine ciliates in the order Hymenostomatida. The primary objective of this investigation will be to collect marine ciliates in the order Hymenostomatida and to establish a system of taxonomy based on precise morphological data.

SUPPORTED BY U.S. National Science Foundation

5.0841, THE ECOLOGY OF COCCOLITHOPHORIDACEAE IN THE ATLANTIC COASTAL WATERS OF THE UNITED STATES

H.G. MARSHALL, Old Dominion College, Graduate School, *Norfolk, Virginia* 23508

The purpose of this research is to determine the spatial distribution of the coccolithophores in Atlantic coastal waters of the United States between Massachusetts and Florida. This represents a quantitative and qualitative study of the coccolithophores and other phytoplankters that are present at different seasons, over a four year time period. Collections have been made along transects over and beyond the continental shelf to depths of 300 meters. Emphasis has been placed on distribution and vertical stratification patterns of these algae and the classification of representative species.

Diurnal distribution patterns and the characteristic phytoplankton of the continental shelf waters, the Gulf Stream, and the Sargasso Sea are included in this investigation. Specific physical and chemical data have also been collected at each hydrostation. The use of an electronmicroscope has been utilized in the identification of coccolithophore species.

SUPPORTED BY U.S. National Science Foundation

5.0842, NATURAL HISTORY OF SALMON POISONING RICKETTSIAE

R.L. OTT, Washington State University, School of Veterinary Medicine, *Pullman, Washington* 99163

The objectives of this project are to expand the knowledge available on the role of helminthic endoparasites as reservoirs and vectors of viral and rickettsial diseases.

Work in this laboratory demonstrated that Neorickettsia helminthoeca the etiological agent of salmon disease of dogs, as well as another as yet unclassified rickettsial agent persist, remain viable and infectious for at least seven years in the metacercarial stage of the fluke Nanophyetus salmincola, encysted in a salmonoid fish. It has also been demonstrated here that the same fluke can transmit, at least mechanically, the virus of infectious canine hepatitis.

Experimental model systems are being developed to demonstrate the persistence and retention of virulence of the virus of infectious canine hepatitis in the canine dog around worm-Toxacara canis-and a dog tapeworm-Taenia taeniaformis. Additional model systems are being developed to show the persistence of the virus of feline panleucopenia in the cat roundworm Toxacara cati and the tapework Taenia taeniaformis.

These experimental model systems will simulate natural endoparasite-virus relationships and hopefully will demonstrate how many infectious agents persist from one host generation to the next.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0843, INPEC BIOLOGICAL OCEANOGRAPHY - (PHYTOPLANKTON AND ZOOPLANKTON RESEARCH)

F. FAVORITE, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

Studies in progress in biological oceanography include phytoplankton productivity and zooplankton ecology.

Productivity and standing stock of phytoplankton and associated physical and chemical factors are measured seasonally in various water masses of the Pacific Subarctic region. The objectives are to assess the seasonal and annual primary production and determine its gross interrelationships with the environment. This work will continue with emphasis on the timing of changes in primary productivity during spring and associated changes of environmental conditions, especially zooplankton.

The zooplankton project is designed to study the seasonal and annual variations in abundance, distribution, and species composition of zooplankton populations with respect to known water regimes and environmental conditions in the central North Pacific Ocean. Current interest is directed toward study of the rapid spring increase of zooplankton organisms. Information from these investigations is necessary to understand the causes of variations in the migratory paths, growth and survival of salmon in the North Pacific Ocean and Bering Sea. Probable spin-off benefits:

specific zooplankton may serve as markers of matter masses and may be critical items in the food chain of other commercially important fishes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0844, PREDICTION OF BIOLOGICAL POPULATIONS FROM THE PHYSICAL OCEANIC ENVIRONMENT

K. BANSE, Univ. of Washington, Graduate School, *Seattle, Washington* 98122 (NONR)

Objective: A precise and reliable modeling technique for the prediction of both temporal and geographic occurrence of marine organisms would provide the Navy with a major informational asset in the resolution of such biologically produced operational problems as the sonic scattering layers. One of the most sensitive factors available for distributional predictions of motile marine organisms is the cosmopolitan and fundamental link in the oceanic food-chain represented by the phytoplanktonic forms. Since the principal theoretical model of plankton abundance extant lacks comprehensive field data for verification and refinement, this work unit has been expressly designed to supply such data and advance the level of predictive competence in this area.

Approach: The principal investigator will utilize commercial 'Ships of Opportunity' plying the Seattle Yokahama route, as well as deploying the R/V Thompson to gather the quantified data necessary to verify or modify the Sverdrup Model of planktonic abundance. Data will be obtained for: chlorophyll A, mixed oceanic layer depth, extinction coefficient of light in the sea, incident surface radiation, volume of plankton, and nutrient concentration. Cruises are being concentrated in the February-June period of rapid planktonic growth and the geographic areas of interest are the temperate and subarctic North pacific.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0845, NUTRIENT LIMITATION AND SOURCES OF NITROGEN FOR MARINE PRIMARY PRODUCTIO

R.C. DUGDALE, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The program is in three main areas: Nutrient Limitation A mathematical model describing the behavior of nutrient-limited phytoplankton populations under steady-state has been constructed. The transient behavior of this model and solutions for more complicated models will be investigated through simulation techniques using digital computers. Observations at sea have indicated silicate limitation in Peru coastal waters and nitrate limitation in the Bering Sea. Using the model for experimental design, attempts will be made to extend and confirm these preliminary observations.

Uptake of New and Regenerated Nitrogen in Primary Production: Measurement of primary production with 15N has been proposed and some measurements already made. Nitrate uptake is called 'new production'. The total amount of new production as nitrate uptake and nitrogen fixation (or atmospheric precipitation in some cases) sets the maximum limit for losses from a steady-state phytoplankton population. Additional measurements using incubation techniques identical to those employed in some 14C measurements of primary production will be made. The technique may be useful in understanding food-chains in some areas.

Nitrogen Fixation A new technique, faster and more sensitive than the 15N method is to be calibrated and modified for use at sea. Acetylene is converted to thylene by the nitrogen fixing enzyme system. The method of detection for ethylene is by gas chromatography. The low cost of the equipment and the simplicity and rapidity of the experimental procedure will make it possible to measure nitrogen fixation over broad areas of the ocean. The increased sensitivity makes it possible to look for low level nitrogen fixation.

SUPPORTED BY U.S. National Science Foundation

5.0846, ANAEROBIC BACTERIA IN THE MARINE ENVIRONMENT

J. LISTON, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

Enumeration and isolation of anaerobic bacterial populations of water, sediments and animals in Puget Sound and adjacent waters will be continued. The presence of terrestrial pathogxenic anaerobes in fish caught in polluted areas and the possible transfer of these organisms to the consuming public via the market chain will be investigated by selective sampling and laboratory experiments.

The identification of anaerobic bacteria isolated from the marine environment will continue by the use of appropriate media and techniques. The function of these organisms and their potential for survival and growth (particularly pathogenic) in the marine environment will be studied by growing isolates over a temperature range on a polythermostat to establish the minimum growth temperatures. In addition to this, the combined effects of temperature and pressure will be investigated.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0847, MARINE PHYTOPLANKTON RESEARCH

R.E. NORRIS, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The primary phases of the research are 1) research on species of coccolithophorids and small dinoflagellates in preserved samples collected in the Indian Ocean; 2) isolation of northeastern Pacific and Indian Ocean species into unialgal culture, and using the isolated species for studies on life-histories, cytology, and nutrition; 3) investigation of species that seem to utilize the water's surface film at some phase of their life-history, with particular attention to the possible ways this adaptation has effected their morphology; 4) studies on consortism and symbiosis in marine phytoplankton, especially with respect to culture of species from tropical and sub-tropical regions. Host and consort are cultured independently if possible, nutritional studies are being carried on, and compared, for the isolated species and the consorting pairs.

SUPPORTED BY U.S. National Science Foundation

5.0848, AQUATIC MYXOBACTERIA - CHONDROCOCCUS COLUMNARIS

E.J. ORDAL, Univ. of Washington, School of Medicine, *Seattle, Washington* 98122

Comparative studies are being carried out on aquatic myxobacteria pathogenic to fish with special emphasis on C. columnaris which is of particular importance as an agent of disease in fishes in the Pacific Northwest. Comparison will be made with cultures isolated or obtained from fish in regions other than the Pacific Northwest. The myxobacteria associated with diseases of Atlantic salmon, reported to be a form of columnaris disease active at low water temperatures, are of particular interest. New antisera will be prepared for identification of specific strains of C. columnaris by antigenic analysis. Further studies will be made on the role of water temperatures in diseases of fishes including exploration of the possibility that high water temperature may induce increased virulence in strains of C. columnaris.

SUPPORTED BY U.S. Atomic Energy Commission

5.0849, MARINE-BACTERIA CULTURE

E.J. ORDAL, Univ. of Washington, Graduate School, *Seattle, Washington* 98122 (NONR)

This research involves: (1) the development of a steady state enrichment culture for selection of particular physiological types of aquatic or marine bacteria, and (2) the investigation of definitive groups of aquatic and marine bacteria. These bacteria include vibrios, stalked and budding bacteria, and myxobacteria.

This problem is significant to the Navy in improving the understanding of important food elements; possible mechanisms of corrosion, deterioration, and fouling, and other areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0850, ECOLOGY OF CLOSTRIDIUM BOTULINUM TYPE E IN GREEN BAY

H. SUGIYAMA, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

The presence of Clostridium botulinum type E in and on the fish of the Great Lakes constitutes a botulism hazard. The organism is particularly prevalent in Green Bay, not only in fish but also in environmental samples. The very low incidence of type E in the soil away from the aquatic environment suggests that passive accumulation of the organisms being carried down from the surrounding land mass is not the only explanation for this distribution. Attempts will be made to show the multiplication of type E in the bay itself. Other sources of the organism which contribute to the maintenance of the type E population in Green Bay will be studied. Effects of other microflora in limiting the growth of type E will be investigated. Contributions of industrial wastes and treated sewage to the growth of type E will be sought. Factors which prevent the multiplication of the botulinal organism in the living fish will be studied. Improvements in the procedures for the detection and isolation of type E from natural samples will be attempted. The relationship between C. botulinum type E and nontoxigenic 'E-likes' will be studied.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5H. ECOLOGY, GENERAL

(environmental Studies Specifically Oriented Toward Effects onOrganisms; Effects of Pollution on Marine Habitats)

5.0851, COASTAL AND INSHORE OCEANOGRAPHY

H.E. BRUCE, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

This project is a comprehensive study of the chemical, biological, and physical oceanography of selected estuarine environments in Southeast Alaska.

The objectives are to describe the general physical, chemical, and biological oceanographic conditions of the inside waters of Southeast Alaska and the seasonal and annual variations in these conditions. The oceanographic work is done in conjunction with other investigations of the Auke Bay Laboratory (Marine Biological Investigations and Shellfish Investigations) and with the Federal Water Pollution Control Administration and the University of Alaska. The combined effort by the above groups resulted in detailed 'ecosystem studies' of selected areas.

The oceanographic studies are broken down into physical and descriptive oceanography and chemical and biological oceanography which results in an over-all comprehensive program in oceanography. Biological oceanography includes studies in phytoplankton ecology, taxonomy, primary and secondary productivity, and energy transfer from the primary producers through the primary herbivores. Also included are studies on dissolved and particulate organic materials and their relations to primary and secondary trophic levels and to benthic organisms.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0852, ESTUARINE STUDIES OF SOUTHEASTERN ALASKA

J.B. KIRKWOOD, U.S. Dept. of Interior, Biological Laboratory, *Auke Bay, Alaska*

One of the aims of the Auke Bay Biological Laboratory is to accumulate detailed descriptive information on environmental characteristics of several estuarine environments within the inside waters of Southeastern Alaska, and to explain ecological reasons for some of the observed differences between environments. The ecological differences are undoubtedly responsible for the annual fluctuations and distributions and abundances of commercially valuable fish and shellfish species.

It is apparent that descriptive knowledge of local populations and their environments are not sufficient in themselves to provide a clear concept of basic ecological and biological principles controlling an ecosystem however, such knowledge is a prerequisite to planning and conducting more detailed and intensive studies of discrete ecological and biological problems.

A cooperative study was initiated in April 1967 that will involve Oceanography Investigations, Marine Biological Investigations, Shellfish Investigations of the Auke Bay Biological Laboratory, and outside agencies such as Federal Water Pollution Control Administration and the Institute of Marine Sciences, University of Alaska.

Each group submits a separate description of its proposed participation in the cooperative estuarine study. The shellfish investigations study involves the following objectives: (1) To determine species composition and relative abundance of pelagic and benthic invertebrates. (2) To determine the relationship between species composition, distribution, abundance, and the environment.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0853, ARCTIC BIOLOGICAL OCEANOGRAPHY

M.B. ALLEN, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

It is well known that the polar seas are among the most productive oceanic areas of the world, in spite of the low temperatures and the fact that the photosynthetic organisms responsible for primary production must spend several months of the year in total darkness and several more months with a notably limited amount of light, which may differ appreciably in spectral distribution from normal sunlight due to absorption end scattering of light by ice and materials trapped in it. The Arctic Ocean is especially rich in phytoplankton and grows few benthic plants, although an extensive benthic algal bed has been reported near Point Barrow, Alaska, and beds of eelgrass are found in several arctic and subarctic locations on the Alaskan coast. If there is active growth of any of these organisms during the winter months, it must imply both the possibility of heterotrophic metabolism of the organisms and the availability of sufficient organic materials to support growth in the waters. The organic material need not necessarily be dissolved; many phytoplanktors have the capacity for phagotrophy. The general objectives of this project are to determine (1) whether growth of photosynthetic organisms does occur during the arctic winter, (2) if so, what organic materials are used by the organisms involved, (3) whether these organic nutrients are present in the waters in which the organisms are found, (4) the yearly light and temperature regime to which the organisms are actually exposed, and (5) what are the mechanisms of adaptation which permit photosynthetic organisms to store sufficient reserves to help them through the months of total darkness in spite of much of a year spent at low light intensity. Both marine and freshwater environments will be investigated.

SUPPORTED BY U.S. National Science Foundation

5.0854, MARINE BIOLOGY IN ALASKA

K.M. RAE, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735 (NONR)

The object of this task is to increase scientific knowledge of the hydrobiology of Alaskan waters and to analyze peculiarly Arctic and sub-Arctic biological conditions. A group of scientists is chosen yearly by the Director of the Institute, with the Scientific Officer's approval, to conduct short-term research in this area. Field work is emphasized. During the coming year, work will continue on cation exchange on particles and the availability of 'sorbed' metals to the biota, and the biology and hydrobiology of the Aleutian Trench. New work will include the isolation of a new amino acid with an unusual chemical structure from marine coelenterates, and possibly from ciliates; the ecology and fine structure of Arctic sponges and the relationship to the silicon cycling in the sea.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0855, ECOLOGICAL STUDIES OF THE COPPER RIVER DELTA

B. HILLIKER, State Dept. of Fish & Game, *Juneau, Alaska*

Objectives: To determine the effect of land uplifting associated with the earthquake of March 27, 1964 on the production of waterfowl on the Copper River Delta.

Procedures: 1. Establish permanent vegetation sampling plots or transects within parts of the Copper River Delta used by ducks, geese, and swans during the breeding season. 2. Using this sampling system, construct a map of the Delta (or a segment of it) showing the present distribution of vegetation types. 3. Obtain detailed descriptions on the plant communities now present, including species composition, the form or structure of each vegetation type, and the sites on which the types are found. 4. Census spring breeding populations of waterfowl by aerial and ground counts, and map areas of high and low density of important species. 5. Measure production through use of permanent nest sampling units, aerial and ground brood counts, and other methods as needed.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Alaska State Government

5.0856, GULF OF CALIFORNIA BIOLOGY

D.A. THOMSON, Univ. of Arizona, Graduate School, *Tucson, Arizona* 85721 (N00014-67-A-0209-0003)

This is a long-term program for the elucidation of the intertidal and oceanic biology of the Gulf of California, a little known area scientifically, but one of real interest due to its isolation, linked with a high incidence of endemism and extreme tidal ranges along the typically hot, arid, desert climate of the Mexican Sonoran Coast. The International Marine Research Station at Puerto Penasco is jointly operated by the Universities of Arizona and Sonora (Mexico), and represents a unique research facility for studies in tropical biology by scientists from both cooperating countries.

This project which has as its goal a predictive level of ecological knowledge concerning those biological entities or systems which may affect Naval activities. In order to make such predictions, it is necessary to know as much as possible about the factors leading to such conditions as: alterations in bottom conditions due to density variations in biological populations, shoreline and emergent beach changes, bioluminescence, and emission absorption, or reverberation of acoustic transmissions.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0857, INTERRELATIONSHIPS OF MARINE ORGANISMS AND SEDIMENTS

R.N. GINSBURG, Bermuda Biolog. Sta. For Res. , *Saint George, Bermuda*

The objective of the proposed program is to bring together exceptional graduate students and staff, from diverse fields of specialization, to observe, study, and to do research on the complex interactions between living organisms, bottom sediments, and rocks, and sea water.

The program consists of two parts: (1) For the first three weeks of the course, students are introduced to shallow-marine environments, their organisms, and sediments. They learn the common organisms, make maps of selected areas, and examine the bottom sediments. Half-day field exercises alternate with laboratories, and lectures. (2) The last three weeks of the seminar are spent on individual research projects of the students' own choosing. This past year each student prepared an illustrated report of his results. These brief papers will be published during the year.

SUPPORTED BY U.S. National Science Foundation

5.0858, ECOLOGICAL SURVEY OF EFFLUENT DISCHARGE AT TWO PULP MILLS IN HUMBOLDT COUNTY, CALIFORNIA

J.A. GAST, Humboldt State College, Graduate School, *Arcata, California* 95521

A continuing study is being carried out on benthic organisms, fish, commercial crabs, and water quality to see if there is any significant affect on the environment by the discharge of pulp mill effluent into the near shore waters of Humboldt County, California.

Sampling of bottom invertebrates with a Smith-McIntyre bottom grab is conducted monthly at specified locations.

Sampling of water for chemical analysis and temperature measurements are made at regular periods.

Sampling of the neckton and commercial crabs by otter trawls. Otter trawl catches are examined on a quarterly basis.

SUPPORTED BY Georgia Pacific Corporation
Crown Simpson Pulp Company

5.0859, THE ECOLOGICAL ARCHITECTURES OF THE MARINE BIOSPHERE

J.W. VALENTINE, Univ. of California, Graduate School, *Davis, California* 95616

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY John S. Guggenheim Memorial Foundation

5.0860, ENVIRONMENTAL BIOLOGY OF TOMALES DAY

E.H. SMITH, Univ. of The Pacific, Graduate School, *Dillon Beach, California* 94929

The principal objective of the research is to learn how marine communities change in time under natural and artificial conditions. It must be stressed that the research now in progress has passed the faunal check list stage and moved into the investigation of individual organisms or groups of organisms and their relationship to the environment in which they are found. Such knowledge is required in order to evaluate and control the effect of man on the marine environment. Tomales Bay is one of the last unpolluted bays on the West Coast of the United States. The establishment of the Point Reyes National Seashore is expected to increase the artificial disturbance of the shallow water marine communities to an appreciable extent. It should be possible to observe the reciprocal effects between the increasing human population and the marine communities by maintaining a program monitoring the ecosystem. Data on physical and chemical parameters will be used to assess the relationship between the environment of individual organisms to the general environment of the region. This information can be used to reconstruct the pathways by which stress is applied to the community. Studies of functional morphology and environmental physiology will help to show how marine species react to changing conditions. The data acquired in these studies can be used to predict the impact of man on the marine environment elsewhere and to the ultimate feedback to human welfare.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0861, MARINE COMMUNITIES

E.W. FAGER, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038 (NONR)

The objective is to understand the structure and dynamics of shallow bottom communities through observations of activities in the natural environment, and measurements of community and environmental parameters. A secondary objective is to extend the same or analogous methods to plankton communities. Measurements of the distribution and life histories of bottom organisms are made by diving. Plankton distributions are obtained from samples collected on cruises to critical areas. Critical points in life histories are checked by culturing organisms in the laboratory. The total approach is a combination of field observation and experimentation with laboratory studies and computer simulation and analysis. In the near future, it is planned to increase the amount of experimental manipulation of the environment, for example, by setting up replicated 'reefs' and moving or rearranging them from time to time. Improvements in the now widely used computer program for grouping will continue.

The key to methods of control, avoidance, or utilization of organisms is frequently found in observations of the kind described here whereas without them, the development of a specific method is often expensive and of limited applicability.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0862, SIMULATION STUDIES OF ECOLOGICAL COMMUNITIES

E.W. FAGER, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

A simulation space program for ecological communities is being developed. It will now take up to 50 species. It uses biologically interpretable input data such as age-specific birth and death rates, growth rates, feeding rates, feeding preferences, etc. All population parameters are in terms of individuals; all growth and feeding relations are in terms of micrograms of carbon. The effects of changes in the input data, of changes in the interrelations between species and of perturbations involving sudden increases or decreases in some species can be investigated. It has been run on data for two species of copepods and two species of chaetognaths that are abundant in the nearshore waters. The results seem to constitute realistic predictions of what is seen in samples taken in the field. A few somewhat unexpected results have been obtained: cannibalism may be an effective way for a predator to maintain itself for a short time in the absence of prey; mortality associated with factors other than predation seems relatively unimportant in control of population size and persistence; in the presence of random variability in reproductive success, a pattern of births spread over several time periods is superior to one with the same intrinsic rate of increase but with the birth all at one time period. The model is being used to explore the consequences of different population parameters and patterns of birth and death and of different predator-prey and prey-prey interrelations.

SUPPORTED BY U.S. National Science Foundation

5.0863, RECENT AND ANCIENT FAUNAS OF A DROWNED ISLAND CHAIN (MID-PACIFIC MOUNTAINS)

W.A. NEWMAN, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The fauna of guyots and deep seamounts remains virtually unknown. Intensive sampling should provide material with which to commence the analysis of several fundamental problems related to the fauna of guyots. Dredging of fossil deposits will provide information pertaining to the composition and affinities of past faunas, their relationship to present Pacific faunas, and the history of submerged islands.

The Mid-Pacific Mountains have been selected for such investigation. They are presently represented by an extensive chain of seamounts and guyots at 1,500 - 2,000 m, separated from one another by considerable depths. During the Cretaceous the guyots stood at the surface as oceanic islands. Fossil outcrops of shallow water origin are known to occur.

Major sampling tools to be employed are, free vehicle trap, set line and camera, pipe dredge, otter and bean trawl, and Isaacs-Kidd Midwater Trawl.

Continuous Reflection Profiling with the Arcer will be used in order to reveal thickness and distribution of sediment overlying ancient land forms.

On an available-time basis, a recently charted seamount N.E. of Midway Island rising to within 35 fathoms of the surface, will be sampled by dredging and coring.

SUPPORTED BY U.S. National Science Foundation

5.0864, INTERACTIONS OF INTERTIDAL POPULATIONS

J.H. CONNELL, Univ. of California, Graduate School, *Santa Barbara, California* 93018 (NONR)

The investigator is analyzing the population dynamics of a selected group of organisms which inhabit the intertidal regions of rocky marine beaches. Particular emphasis is placed on the interrelationships involving the activities of predators and prey animals and the environmental factors which contribute to the equilibrium of the system.

Because the Navy conducts its operations in the oceans, it is necessary to understand as much as possible about their ecology and the factors influencing it. Marine biological communities pose many specific problems, the group under study contributing notably to fouling and deterioration, modification of bottom sediments or beach conditions, masking of acoustic signals. The phenomenon of community dynamics and balance, however, applies even more broadly and relates to all aspects of hydrobiology.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0865, ECOLOGICAL STUDIES OF ROCKY SUBTIDAL AREAS

C.H. TURNER, State Dept. of Fish & Game, *Terminal Island, California*

Objective: To study the plant and animal communities of rocky subtidal areas, including taxonomic classification and correlation between species and their relationships to sport fish populations.

Procedures: Studies will be devised to answer questions on the total ecological picture of these rocky subtidal areas, including interrelationship of species, relationship to substrate, and relationship of each to sport fishes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
California State Government

5.0866, ECOLOGY OF PANAMANIAN REEF COMMUNITIES

P. GLYNN, Smithsonian Institution, *Balboa Heights, Canal Zone*

Studies on the ecology and behavior of tropical marine invertebrates.

SUPPORTED BY Smithsonian Institution

5.0867, ECOLOGY OF THE PORITES FURCATA REEF-FLAT COMMUNITY

P.W. GLYNN, Smithsonian Institution, *Balboa Heights, Canal Zone*

This project is concerned with studies on the ecology of the shallow-water Porites furcata assemblage which occurs on the reef-flat habitat of coral reefs located along the southwestern coast of Puerto Rico and on the Atlantic seaboard of Panama. Initial, major emphasis has been given to a study of the meteorology, hydrography and plankton populations. Additionally, a systematic program involving the procurement of quadrat samples and other quantitative measurements needed to assess spatial and temporal variations of the biota, has been executed on a long-term basis. The ultimate aim of the investigation is to obtain information on the following aspects of the coral community. a. composition and structure of the biological components; b. food interrelationships; c. movement of energy and materials through the assemblage.

SUPPORTED BY U.S. National Science Foundation

5.0868, ZONATION OF THE WEDDELL SEA BENTHOS

J.S. RANKIN, Univ. of Connecticut, Graduate School, *Storrs, Connecticut* 06268

The Weddell Sea, an area of essentially constant environmental characteristics, is an ideal 'laboratory' for the study of factors affecting the distribution of marine benthic organisms. The prevailing hypothesis, that these organisms are zonally present because of temperature regimes, will be tested through intensive collections at a few stations at representative depths. The waters in this sea should be at essentially the same temperature at the various depths. Similarity or differences in species distribution and abundance, therefore, may be ascertained, with temperature a 'controlled' factor. Subsequent studies should evaluate other factors than temperature.

SUPPORTED BY U.S. National Science Foundation

5.0869, AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE - LABORATORY PROCEDURES

F.C. DAIBER, State Board of Game & Fish, *Dover, Delaware*

Objective: An evaluation of the effects of various types of marshland management on the diurnal and seasonal concentrations of phosphorus and nitrogen in tidal marshes.

Procedures: The water samples collected in the field will be processed in the following manner: 1. Inorganic phosphorus - Reimold, R. J., 1965. An evaluation of inorganic phosphate concentrations of Canary Creek Marsh. This procedure requires that inorganic phosphorus determination be made immediately after sample collection to avoid errors due to sample storage. The determination, a spectrophotometric technique, requires electrical power. 2. Total phosphorus - Water samples for total phosphorus concentrations are processed upon return to the Bayside Laboratory. The sample is oxidized in an ordinary autoclave according to the technique of Menzel, D. and Corwin, N. 1965. This procedure converts all phosphorus to the inorganic form which can then be measured by the technique of Reimold as cited above. 3. Organic phosphorus concentration is determined by the difference between the initially measured inorganic form and the subsequent total phosphorus determination. 4. Nitrate nitrogen - Wood, E.D., F. A. J. Armstrong, and F. A. Richards. 1967. This technique offers extreme accuracy and is easily used in the field. In this new method nitrate is converted to nitrite and then measured as in number 5. 5. Nitrite nitrogen - Strickland, J.D.H., and T. R. Parsons. 1960. A manual of sea water analysis. Fish Res. Bd. Can. 125:71-74. 6. Ammonia nitrogen - Roskam, R., and D. de Langen. 1964. A simple colorimetric method for the determination of ammonia in sea water. Anal. Chim. Acta 30: 56-59. 7. Salinity will be measured by the conductance method using an induction salinometer

The results will be processed for computer evaluation of the various suspected relationships between the phosphorus and nitrogen concentrations and related physical parameters measured. The I.B.M. computer program STUFF (Sixteen Twenty Universal Function Fitter) will be used to determine significant relationships between organic phosphorus, inorganic phosphorus, total phosphorus, nitrate, nitrite, ammonia, salinity, water temperature, air temperature, tide state, time, lunar phase, day of year and weather. Other statistical and graphical techniques may also be employed to interpret the data.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Delaware State Government

5.0870, TIDE MARSH ECOLOGY AND WILDLIFE

F.C. DAIBER, Univ. of Delaware, Graduate School, *Newark, Delaware* 19711

This project involves an analysis of phosphorus and nitrogen compounds in tidal marsh drainage with an evaluation of the effects of various types of marshland management. Preliminary results indicate that highest concentrations of nitrate and nitrite nitrogen were found in winter. Inorganic phosphorus concentrations appear to be much higher in the marsh than in the adjoining estuary, indicating that salt marshes are an essential part of the phosphorus cycle. The differences between phosphorus and nitrogen levels may be highly important in regulation of primary productivity in the salt marsh. Nutrient cycles are difficult to understand and much additional work needs to be done.

Another part of this project is a study of the biochemical effects of microorganisms upon the salt marsh environment. The objectives of this were to enumerate and identify the microorganisms indigenous to the salt marsh and to relate the known metabolic processes of the organisms found to the chemical cycles being investigated. It appears these microorganisms are extremely important in the nitrogen and phosphorous cycles in the salt marsh ecosystem.

SUPPORTED BY Delaware State Government

5.0871, ECOLOGY OF SABELLARIID REEFS IN DELAWARE BAY

H.W. WELLS, Univ. of Delaware, Graduate School, *Newark, Delaware* 19711

This study will document the pattern of distribution of sabellariid reefs in Delaware Bay and attempt to relate distribution to major physical factors of the environment: to turbulence, salinity, dissolved oxygen, and seasonal changes in temperature. The community relationships of these polychaetes and their tube masses will be examined, with particular attention to recognizing predators in the community and distinguishing them from species which use the masses primarily for attachment (fouling organisms), for shelter (crevice dwelling forms), or as a source of nutritive fecal pellets from the worms (scavengers). Quantitative observations will be made upon seasonal patterns of reproduction, settling, and growth of the worms and of the masses. Investigation includes an evaluation of the role of sabellariid polychaetes as a cementing agent of bay sediments, as an indicator of current and wave activity, as a provider of hard substrates suitable for the attachment of oysters, bryozoans, and other sessile organisms, and as an important element in the feeding relations of many animals.

SUPPORTED BY University of Delaware

5.0872, CORAL ATOLL ECOLOGY

F.R. FOSBERG, Smithsonian Institution, *Washington, District of Columbia* 20560

Collecting and organizing information on coral atolls, especially on the terrestrial aspects of them; developing an understanding of ecological relationships and processes in operation in these islands; describing the coral atoll ecosystems. Preparation of bibliography of such information and summaries of certain aspects of it.

SUPPORTED BY Smithsonian Institution

5.0873, PHYSIOLOGY AND ECOLOGY OF THE ADRIATIC BENTHOS

K. RUTZLER, Smithsonian Institution, *Washington, District of Columbia* 20560

This work will be a continuation of research begun in 1965. The project will comprise development of suitable instruments for measuring the microclimate (flow of water, light, oxygen, etc.) around selected benthic organisms, actual measurement of these microclimates and determining the importance of various factors for the well-being of the benthic communities, and laboratory experiments on the physiology and biochemistry of selected organisms.

SUPPORTED BY Smithsonian Institution

5.0874, MARINE BIOLOGY STUDIES ON FAIRFAX ISLAND

I.E. WALLEN, Smithsonian Institution, *Washington, District of Columbia* 20560

Field studies and collections will be made at Fairfax Island in the Barrier Reef area off Australia. Data will be collected and specimens will be forwarded to the Smithsonian Institution.

SUPPORTED BY G. Unger Vetlesen Foundation

5.0875, ESTURAINE ECOLOGY--INDIAN RIVER, DELAWARE

J.L. CHAMBERLIN, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Washington, District of Columbia*

Preparation of a report on bi-weekly environmental observations along White Creek, a tidal tributary of the Indian River estuary.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0876, BIOGEOGRAPHY OF BENTHONIC ORGANISMS

J.L. CHAMBERLIN, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Washington, District of Columbia*

Description, explanation, and prediction, of the geographic dustribution of selected species of bottom dwelling marine organisms. Attention is primarily on sedentary species because their distributions are relatively stable and more amenable to analysis than the constantly shifting distribution of mobile species. Emphasis is on species inhabiting the continental shelf region of eastern North America, and offshore species are stressed rather than estuarine and shallow-water coastal forms. The results are presented primarily in the form of maps of distributional data on species, and maps of the distribution of limiting environmental conditions (barriers) for the particular species involved.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0877, AN ECOLOGICAL STUDY OF SOUTH BISCAYNE BAY IN THE VICINITY OF TURKEY POINT

R.G. BADER, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124 (AT(40-1))

This proposal is for a study of the ecology of south Biscayne Bay with particular attention to the environs of the Turkey Point power station. The existing and relatively unspoiled biological situation will be studied with regard to the hydrology and chemistry, phytoplankton, zooplankton and benthic organisms. The biology of the organisms will be considered in relation to temperature, salinity ranges, and some gross chemical characteristics. Also, the effect of potentially higher temperatures on the dominant and subdominant species will be studied in the field and later in the laboratory. Information presently available in relevant areas of study (i.e., publications and research logs of the Institute of Marine Sciences) will be further analyzed and utilized in this program.

Because the first power unit of the Florida Power & Light Company plant is now in operation, it will be necessary to choose several control sites in order to monitor the changes which have already started to occur. Some rise in temperature and in the copper and iron content of the water near the effluent have already been observed during preliminary studies made by this Institution.

SUPPORTED BY U.S. Atomic Energy Commission

5.0878, WATER QUALITY AND FUNGI-NEMATODE-SEAGRASS RELATIONSHIPS

S.P. MEYERS, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

Studies involve analyses of the fungal and nematode populations in Biscayne Bay, Florida, and their interrelationships within seagrass communities. Major attention is directed toward ecological and bionomical analyses of foliicolous and benthic nematodes, life cycle studies, and examination of animal succession patterns in specific habitats. Fungal studies concern physiological investigations of specific taxa and broad comparative investigations of cellulolytic activity especially that of the dominant representatives of the marine mycota. Levels of enzymatic production and related weight loss of cellulose, are compared with those of non-marine cellulolytic species. Projected lines of nematode study include analyses of the benthic nematode biota within other types of turtle grass communities, characterization of the oncholaimid population in the Bay to determine the extent and range of specific abundant taxa and their extant sex ratio, and further examination of factors affecting attraction and aggregation of marine nematodes to sites of organic deposition and decay.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0879, THE BIOLOGY OF THE INFAUNA OF A TROPICAL SOFT BOTTOM AREA

H.B. MOORE, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

A study is in progress on the biology and ecology of the infauna of the soft bottom of Biscayne Bay, Florida. This is considered typical of a tropical estuarine area. Papers have been published on the heart urchin, Moira atropos, and the lamellibranch, Tagelus divisus. Papers are in press on Chione cancellata on the fauna of intertidal muds, on sublittoral polychaetes and the biological effects of pollution in the bay. Studies are in progress on various mollusks, echinoids and brittle stars.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0880, EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY

T.S. HOPKINS, Univ. of West Florida, Graduate School, *Pensacola, Florida*

The campus of The University of West Florida is located on the west side at the head of Escambia Bay, a commercially important estuary for the production of oysters, shrimp, and fish. Part of the drainage basin of this estuary, including an embayment or bayou and small stream lies on University property that has been dedicated as a natural conservation area and will remain undeveloped.

The Faculty of the Department of Biology and Marine Sciences plans to initiate a continuing study of this habitat to determine the ecological relationship. Concurrently, a similar habitat on the east side of the bay that is not protected from man's encroachment will be studied in comparative detail to determine the effects of pollution. It is anticipated that the program will serve as a training program for graduate students in the field of marine biology.

An initial 12-month program is proposed that has the following objectives: 1. A physical, chemical, and biological inventory of the two bayous adequate to provide an understanding of the resident plant and animal communities; and, 2. An analysis of migratory fauna and their 'input' into the ecosystem; and, 3. A periodic surveillance project will monitor the water, bottom deposits and biota for pesticide residues. (These are anticipated because of the routine use of these chemicals in the drainage basin).

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0881, PESTICIDES

P.A. BUTLER, U.S. Dept. of Interior, Biological Laboratory, *Sabine Island - Gulf Breeze, Florida*

Although commercial formulations of synthetic pest control chemicals are screened for mammalian and target-animal toxicity levels, little is usually known of their possible effect on marine animals. Theoretically, there is the possibility of any and all of these chemicals draining into estuarine areas important to fish and shellfish.

This project determines acute and chronic toxicity levels of potential and commercial pesticides to representative marine fauna including but not limited to oysters, shrimp, and mullet. Tests are conducted in a flowing sea water system or in the field. Special studies are underway to determine most suitable testing techniques and bioassay animals.

Studies of the kinetics of persistent pesticides following pilot-scale applications in the field are being expanded. Residue analyses of sub-strata and food-chain organisms are made to determine ultimate fate of chemicals and possible danger sites.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0882, LABORATORY BIOASSAYS

J.I. LOWE, U.S. Dept. of Interior, Biological Laboratory, *Sabine Island - Gulf Breeze, Florida*

The primary objectives of the subject project are: (1) determination of the acute toxic levels of pesticides to representative marine species, and (2) investigation of possible adverse effects of prolonged exposure of marine animals to sublethal concentrations of the common pesticides.

Short-term (96-hour or less) toxicity tests are conducted in the laboratory under controlled conditions. Most of the tests are conducted in constant-flow seawater systems using oysters, shrimp, and marine fish as bioassay animals. These acute toxicity tests will be a continuing function of the project as new chemicals are received for evaluation.

Long-term experiments (3 to 6 months duration) involving the chronic exposure of marine animals to sublethal concentrations of selected pesticides will be conducted when the efforts and results seem justified.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0883, ESTUARINE ECOSYSTEMS

G.E. WALSH, U.S. Dept. of Interior, Biological Laboratory, *Sabine Island - Gulf Breeze, Florida*

The purpose of this research is to determine effects of sublethal concentrations of pesticides upon estuarine ecosystems. At present, physical, chemical, and biological characteristics of four very similar coastal ponds are being analyzed to learn normal seasonal variations. When these are known, three of the ponds will be treated with pesticide and one with be utilized as a control. Effects of pesticide upon population dynamics and community structure will be studied after contamination.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0884, ECOLOGICAL STUDY OF CHARLOTTE HARBOR ESTUARY AND SHARK PROGRAM OF MOTE MARINE LAB

P.W. GILBERT, Mote Marine Laboratory, *Sarasota, Florida* 33581

A long-term ecological study of the Charlotte Harbor-Pine Island Sound estuary. This study of a relatively uncontaminated

250,000-acre body of water over a period of years will yield invaluable information to assist in the evaluation of the impact man makes as he continues to invade the area and modify the environment.

Projects involving the behavior, physiology, anatomy, endocrinology and biochemistry of sharks are continuously in progress. Use of this vessel in the collection of sharks has greatly facilitated this program.

SUPPORTED BY U.S. National Science Foundation

5.0885, DISTRIBUTION OF LIFE WITH DEPTH

R.J. MENZIES, Florida State University, Graduate School, *Tallahassee, Florida* 32306

The objective of this proposal is to improve our knowledge of the distribution of animal life in the sea directly off the coast of North Carolina through a detailed photographic study on selected biological properties of the sea floor from shelf depth (180 meters plus or minus 20 meters) to the abyssal plain (6000 meters).

As a mechanism of significant improvement of the use of underwater photographs in biological studies, each photographic series will be coupled with samplings of animal life. Thus, this project involves the use of a grab camera, a multi-shot camera coordinated with large trawl samples, identification of species photographed, correlation of observed distribution with sediment type and hydrographic information. The aim will be to associate gross and reproducible features in the distribution of animal life with topography, hydrography (water characteristics, T, S, O2) and sediment type.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0886, ECOLOGY OF KRAFT PAPER MILL EFFLUENT IN SAPELO & ST. CATHERINES SOUNDS, GA

M.D. DAHLBERG, Univ. of Georgia, Marine Institute, *Sapelo Island, Georgia* 31327

This study will survey the ecological effects of kraft mill effluent from the Interstate Paper Co. in Riceboro, Ga. This study will determine changes, if any, in the chemistry, flora and fauna of the study area including Riceboro Creek, North Newport River, Sapelo Sound and St. Catherine's Sound.

SUPPORTED BY Georgia State Government

5.0887, AEGEAN SEA BIOLOGY

V. KIORTSIS, Athinisin Eth Kai Kap Panpstmn, *Athens, Greece* (N62558-3693)

This research is an ecological study of northern areas of the Aegean Sea. Emphasis is on the determination of the environmental factors which influence the distribution of plankton and bottom organisms of that area. Qualitative and quantitative analyses are made of daily and other cyclical fluctuations of environmental factors in an attempt to discover the mechanisms by which they affect the biological populations.

Biologically, the Aegean Sea is virtually unknown and hydrographic data of the area are sparse and sporadic. It is, however, especially interesting because of the extensive shoreline and the intricate currents around the Islands. The exchange of water with the Sea of Marmara and the Black Sea adds to the wide variety of ecological conditions and makes the area a particularly valuable base of research operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0888, INVESTIGATE FACTORS DETERMING DISTRIBUTION OF PHYSICAL AND CHEMICAL PROPERTIES OF THE PACIFIC OCEAN

R.A. BARKLEY, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Honolulu, Hawaii* 96812

Studies of Pacific-wide oceanographic conditions already underway reveal certain classes of deviations from average conditions which are being investigated in a variety of ways. For example, the effects of mid-ocean island groups on the distribution of properties, as well as on currents, are evident, and are being studied by means of field investigations including direct current measurements; theoretical analysis including mathematical modeling with a computer; and physical modeling using a scale hydrodynamic model of the Hawaiian Islands. Winter-summer changes in properties are associated with water-mass formation and dissipation, which will be studied using field data and mathematical models. Long-term changes are also evident in synoptic sea-surface data obtained at nine monitoring stations maintained on islands throughout the central Pacific; these changes are being studied by means of Fourier analysis, which yields information on amplitudes and phase angles of periodic changes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0889, BIOLOGICAL RESEARCH ON THE VOLCANIC ISLAND SURTSEY AND ENVIRON

S. FRIDRIKSSON, Surtsey Research Society, *Reykjavik, Iceland* (AT(30-1))

Research on the terrestrial biota of the new volcanic island, Surtsey was continued during the year 1967, using the unique opportunity for studying dispersal, colonization and succession of plants and animals. Plant parts continued to disperse by ocean to the previously sterile islands. These were classified and recorded and when growth started, the locations of the plants were mapped. Already four species of coastal plants have colonized the island, Cakile edentula, Honckenya peploides, Elymus arenarius and Mertensia maritima as well as two mosses, Funaria hygrometrica and Bryum argenteum. Birds were also found to take part in the dispersal. Of the 14 species of migratory birds caught on the island during the spring, snow buntings were found carrying seed in their gizzards. As these birds had apparently migrated from the British Islands on their way to Greenland this must be regarded as a case of long distance dispersal of seed. As the immigration, however, most likely takes place from the close neighborhood, the vegetation of other islands in the group was studied. For comparison an ecological study of vegetation on a nunatak in the glacier Vatnajokull was continued. Regarding terrestrial invertebrates already 63 species have been recorded on Surtsey of which 37 species were discovered in 1967, the majority of these being casual visitors whereas only certain flies as Leria modesta, breeding in carcasses on the shore are permanent inhabitants. A meteorological station was established for climatic observations and a small field laboratory has been built on the island.

SUPPORTED BY U.S. Atomic Energy Commission

5.0890, ECOLOGICAL SUCCESSION ON SURTSEY

S. HERMANNSSON, Surtsey Research Society, *Reykjavik, Iceland* (F61052-67-C-0087)

A comprehensive coordinated study of the biological development of the new volcanic island ‘Surtsey‘ will be continued with emphasis on geological and meteorological contributions to the total ecology. Especially considered is the succession of biological communities which establish themselves on the newly emerged areas of new land and the factors which determine or influence the sequences.

The solution to the Navy's problem of fouling and deterioration of underwater equipment will depend on an ability to predict the sequence of biological events. The land mass formed as a result of the volcano provides a unique opportunity to observe one set of these sequences under natural conditions.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0891, MARINE BIOLOGY OF RED SEA AND EASTERN MEDITERRANEAN

L. FISHELSON, Tel Aviv University, *Tel Aviv, Israel* (F61052-67-C-0043)

The investigator and his staff are conducting a comprehensive series of ecological studies in the Red Sea and Mediterranean Coast of Israel. Distribution of the dominant forms of plant and animal life, especially the benthic forms, is being mapped and related to environmental conditions and bottom sediments at mid-depth and in abyssal regions. Information is being collected on the population dynamics, life histories, and physiology of the organisms present in the Red Sea with emphasis on the many forms which are newly discovered.

Because these waters are virtually unknown with regard to their ecological and biological regimes, it is essential that more information be collected on all environmental characteristics of this area. These studies are particularly important since they involve an area in which the effects of engineering operations on the environment can be studied. The effects of the Suez Canal on the oceanography and biology of the Red Sea are dramatically observable, and it is expected that great changes in the Eastern Mediterranean will follow the completion of the Aswan Dam. Information collected relates to sound transmission effects, abundance and distribution of marine fouling and boring organisms, and ambient noise levels.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0892, MARINE LABORATORY
J.G. BROOM, State Wildlife & Fish Comm. , *New Orleans, Louisiana*

This project area incorporates all six of the previous described phase areas, namely coastal Louisiana. Here, the project leader will compile, analyze and interpret the date.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Louisiana State Government

5.0893, HYDROGRAPHIC AND BIOLOGICAL SURVEY OF MONTSWEAG BAY AND VICINITY
D. DEAN, Univ. of Maine, Ira C. Darling Ctr. For Res. , *Walpole, Maine* 04573

This project will investigate the quantitative distribution of benthos (by Ponar grab sampling), the types and distribution of zooplankton (010 net plankton), and the distribution of temperature and salinity in space and time in Montsweag Bay and vicinity. This study is a short-term (June to August 1968) pilot project for a long- range research program anticipated to begin in 1969 and extend through 1973. The latter project will monitor before-and-after changes accompanying the operation of a nuclear-powered electric generating plant scheduled to commence operation early in 1972.

SUPPORTED BY Maine Yankee Atomic Power Company

5.0894, WATER QUALITY - BENTHIC INVERTEBRATE RELATIONSHIPS IN ESTUARIES
D. DEAN, Univ. of Maine, Ira C. Darling Ctr. For Res. , *Walpole, Maine* 04573

This project proposes to investigate the relationships between water quality and benthic invertebrates in Maine estuaries. Studies will be conducted in three estuaries, the Penobscot, the upper reaches of the Damariscotta and the Sheepscot, representing heavily polluted, moderately polluted and unpolluted conditions, respectively. Comparable portions of each estuary will be studied to determine the benthic communities present, the settlement of benthic invertebrate larvae, larval metamorphosis, and the growth and survival of juvenile forms. Hydrographic, chemical and geological parameters of the waters and sediments will be measured and used as guidelines for controlled laboratory experiments on larval settlement.

The results of this project should aid 1) in the interpretation of fish distribution patterns in estuaries subject to different levels of pollution and 2) in predicting biotic changes that would occur in an estuary subjected to increased or decreased pollution loads.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Maine

5.0895, AN ENVIRONMENTAL SURVEY OF THE DAMARISCOTTA RIVER ESTUARY, LINCOLN COUNTY, MAINE
B.J. MCALICE, Univ. of Maine, Ira C. Darling Ctr. For Res. , *Walpole, Maine* 04573

The present environmental characteristics of the Damariscotta River are little known, and may be significantly altered by the construction of a sewage treatment plant in the upper estuary.

Temperature and salinity distribution, the volume of fresh water entering the estuary, current velocities, and basin topography are being used to derive a picture of the salt balance, exchange rates, and circulation patterns.

Bottom grab and core samples will be taken to determine the present sediment distribution and recent changes in the sedimentation regime.

Intensive sampling of inorganic nutrient species is being carried out to determine the nutrient distribution in the estuary and the influence of present small quantities of raw sewage on the distribution.

Hydrographic and nutrient data will be used to predict the effect of the proposed treatment plant on the environmental characteristics of the estuary.

SUPPORTED BY Maine State Government

5.0896, ECOLOGICAL STUDIES OF ATLANTIC AND GULF COASTAL ESTUARIES OF IMPORTANCE TO WATERFOWL
H.D. IRBY, U.S. Dept. of Interior, Patuxent Wlife. Res. Ctr. , *Laurel, Maryland*

The estuaries, sounds, and bays of the Atlantic and Gulf Coasts are of primary importance to the bulk of migrating and wintering waterfowl of the Atlantic, Mississippi, and Central Flyways. These habitats are of particular importance to diving ducks, for which we have few good habitat management techniques.

These areas are among the most susceptible to destruction from channelization, industrial development, real estate development, hurricanes, regulation of river flows, marsh drainage for mosquito control, and pollution from many sources. Because of the difficulty of making accurate observations of the productivity of estuaries, the distribution, abundance, quality, and quantity of the biota of these areas are more poorly known than most other waterfowl habitats.

This broad-scale study will provide much-needed information on the value and quantity of the estuarine habitat still of importance to waterfowl and establish a historical record of those values. The broad scope of this study makes it imperative that adequate planning and preliminary reconnaissance be conducted prior to finalizing specific work units. Initially, one biologist will conduct the needed reconnaissance to organize the program and formulate the specific plans.

This project will be started in fiscal year 1966 and will include a period of at least 5 years to determine major patterns of trends and fluctuations in estuarine vegetation and waterfowl use.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0897, OCEAN WATER INTRUSION INTO BACK BAY, VIRGINIA, & CURRITUCK SOUND, NORTH CAROLINA, ON THE WATERFOWL & FRESHWATER FISH HABITAT
J.L. SINCOCK, U.S. Dept. of Interior, Patuxent Wlife. Res. Ctr. , *Laurel, Maryland*

The initial investigation into the ecology of Back Bay, Virginia, and Currituck Sound, North Carolina, was terminated on March 7, 1962, when an Atlantic Coastal storm introduced ocean water into the fresh to slightly brackish water of the area. The second phase of the investigation is now in progress and its objectives are to determine the effects of the increased water salinity on the waterfowl and fresh water fish habitat. The methods employed are identical to the first phase of the investigation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0898, ECOLOGICAL STUDY OF DUXBURY BAY
C.A. WILLINGHAM, William F. Clapp Laboratories, *Duxbury, Massachusetts* 02323

The purpose of this study is to survey the flora and fauna of Duxbury Bay and establish the pattern of interactions between these organisms and the various environmental parameters found in Duxbury Bay. The Bay itself is a relatively high salinity area with a fifteen foot tidal amplitude. Twice each day the bay bottom is left exposed by the out-going tide. Data are collected on the various organisms from twelve stations along transects which cross the Bay.

SUPPORTED BY Battelle Memorial Institute

5.0899, YEAR-ROUND PROGRAM OF RESEARCH IN MARINE ECOLOGY

M.R. CARRIKER, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

A year-round, long-term program for basic research and training in the systematics and ecology of the marine biota of the area was initiated in 1962 with the assistance of funds from the Ford Foundation and grant NSF GB-561. The present request is for continued support for research and advanced training in the coherent area of marine ecology of the Cape Cod region. The research will stress ecological life histories and populational ecology with reference to the complex of environmental parameters. the commonest dominant marine and estuarine species along the coast, and even less of organisms off the coast. Especially lacking is information on the ecology of larval and early post-set stages. Research associates participating in the program will select specific problems on some aspect of the marine ecology of the region. These concerted studies should add important information to our knowledge of the ecology of marine organisms of the northeast coast of the United States. A second benefit of the program is the increased training of individuals in marine ecology. The results of these investigations will enhance the work of other biologists who participate in the Laboratory's summer program.

SUPPORTED BY U.S. National Science Foundation

5.0900, BENTHONIC BIOLOGY

M.R. CARRIKER, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543 (NONR)

This is a long-term, year-round comprehensive study of the biota of Cape Cod region using standardized collection and analysis methods. Pelagic, as well as bottom organisms to a minimum size of 1 mm are included. The major purpose is to understand the spatial and temporal distribution and density of organisms relative to temperature, salinity, bottom substrate and biological neighbors. Taxonomic studies are also included. Scuba divers make direct observations and the most up-to- date equipment available is being used from shipboard. New equipment designs are also being developed.

Attention is focussed on the composition and ecology of organisms living in, on, or near, the sea bottom. Not only do these organisms most often contribute to the fouling mass, but they directly affect the characteristics of the sediments. They may consolidate the bottom, or prevent its consolidation, and lead to shifting and instability.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0901, THE OCEANOGRAPHY OF NEW ENGLAND FISHING BANKS

D. BUMPUS, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

The purpose of the research is to determine the relationships between meteorological conditions, hydrographic conditions, and the distribution and abundance of groundfish in the ocean between Nova Scotia and New Jersey. Methods include standard hydrographic cruises, release of drift bottles, and sea bed drifters and the collection routinely of meteorological and hydrographical information from lightships and Texas Towers along the entire Atlantic Continental Shelf.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0902, BIOLOGY OF THE DEEP-SEA BENTHOS

H.L. SANDERS, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

Diversity, zonation and density were the major research interests of our deep-sea benthic program during the period of July 1, 1967 to June 30, 1968. Our findings on the Gayhead-Bermuda Transect of low animal density, pronounced faunal zonation, and very high diversity were verified in our sampling of bathyal and abyssal depths in the tropical Atlantic. We therefore conclude that these features are universal attributes of the deep-sea benthos. The diversity of our deep-sea samples is about the same order of magnitude as that present in tropical shallow seas and considerably greater than equivalent shallow boreal marine and tropical and boreal estuarine environments. We are also able to measure the horizontal as well as the vertical component of deep-water benthic zonation using a modification of the rarefaction methodology. At least for the groups examined, a change of a few hundred meters vertically is equivalent to thousands of kilometers horizontally.

SUPPORTED BY U.S. National Science Foundation

5.0903, ENVIRONMENTAL CHANGES IN LAKE ERIE

J.F. CARR, U.S. Dept. of Interior, Biological Laboratory, *Ann Arbor, Michigan*

Lake Erie has experienced major changes in the benthos and fish populations. Analyses of physicochemical data show that concentrations of most major ions have increased significantly, very low dissolved oxygen concentrations occur during the summer, and mean annual water temperatures have increased. Present studies are directed toward documenting the extent of change in the benthos and studying the factors which result in the oxygen depletion of the hypolimnetic waters. Laboratory and field studies are being made of the exchange of nutrients and the oxygen demand at the mud-water interface.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0904, PHYSIOLOGY AND BEHAVIOR

T.A. EDSALL, U.S. Dept. of Interior, Biological Laboratory, *Ann Arbor, Michigan*

Laboratory and field studies are underway to determine the potential productivity of Lake Michigan for intermediate and top carnivores. Recent biological changes in Lake Michigan that have altered the lake's trophic structure are under investigation. Analysis of food chains and energy flow within and between trophic levels will include studies of food preference, food competition, and the efficiency of utilization. The effects of the chemical and physical factors of the environment on the physiology and behavior of native and exotic species are being investigated. Special emphasis will be placed on determining the role of these factors as controlling mechanisms in energy flow and productivity in the ecosystem.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0905, EXPLORATORY COLLECTION AND CARE OF AQUATIC INVERTEBRATES FOR TESTING AT TIBURON

T. LANE, U.S. Dept. of Interior, Fish Pesticide Res. Lab. , *Columbia, Missouri* 65201

It is necessary to explore sources of brackish-water and marine invertebrates for pesticide bioassay work at Tiburon, and to determine the most feasible procedures for collecting and holding the test animals. Areas in San Francisco Bay and the delta of the Sacramento- San Joaquin will be searched, and culture of animals will be studied at Tiburon, and holding facilities will be tested under various space, time, feeding, and water flow conditions.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0906, TOXICANT TOLERANCE STUDIES - SCREENING OF PESTICIDES AND AQUATIC INVERTEBRATES AT TIBURON

T. LANE, U.S. Dept. of Interior, Fish Pesticide Res. Lab. , *Columbia, Missouri* 65201

The work will be performed to obtain acute toxicity information on marine and estuarine aquatic invertebrates with insecticides, herbicides, and other pesticides at Tiburon, California. Invertebrates and toxicants will be tested in continuous-flow systems in the laboratory, according to a standard test method, and the data will be treated by probit analysis to obtain LC50 values under various time schedules.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0907, PRE-CONSTRUCTION ENVIRONMENTAL SURVEY

L. OGREN, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

Conduct an ecological, hydrographic and geological investigation of potential reef sites from New England to Florida by periodic underwater observations at each area selected for construction. Sampling techniques will depend upon water conditions and diver support facilities at each locality. Observations will be made on the existing fish fauna and benthic organisms using standard sampling methods, i.e., swimmer transects, timed observation periods, and random quadrants. Faunal collections for identification and bottom samples for sediment analysis will be taken at each locality. Water temperature, salinity, transparency, and current direction and velocity will be recorded at the construction sites. Natural reefs and other bottom disconformities in the construction areas will be investigated in order to evaluate the reef fishing potential for each region.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0908, ESTUARINE DREDGE HOLE INVESTIGATIONS

W.S. MURAWSKI, State Div. of Fish & Game, *Trenton, New Jersey*

Objectives: To summarize our studies on the ecology of submarine estuarine dredge holes, especially in regard to finfish habitation.

Procedure: Information relative to the location of estuarine dredge holes, their area, depth and other physical characters gained during the course of four years of field work will be analyzed and brought together in a final report.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
New Jersey State Government

5.0909, EUTROPHICATION OF TIDAL WATERS

J.P. BARLOW, State University of New York, School of Agriculture, *Ithaca, New York* 14850

The objective of this investigation is to determine the effect of allocthonous nutrients on the growth of algae in tidal waters. The pigment content, and rate and efficiency of photosynthesis of algae will be measured in natural populations and in impounded populations subjected to experimentally modified nutrient levels. Differences in these measurements of physiological state will be related to differences in nutrient supplies. From these relations it is hoped to obtain quantitative expressions for the effects of nutrient levels on the rate of photosynthesis of populations which can be used in dynamic models to predict effects of changes in nutrient levels on growth kinetics of algal populations.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0910, CONTINUAL MONITORING OF AREA THROUGHOUT SPAWNING, SETTING, AND GROWING PERIOD

W.S. MILLER, State Div. of Fish & Game, *Oakdale - Long Island, New York* 11769

Continual monitoring on a semi-weekly basis to determine biological, physical, and chemical characteristics and to determine intensity of spawning, setting, and survival in this area so that comparisons can be made with known ponds which do produce good sets on a sustained annual basis.

This phase will commence on a limited basis upon project approval and semi-weekly beginning several weeks prior to anticipated favorable conditions for spawning.

Part 4 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
New York State Government

5.0911, ACCUMULATION OF RADIOACTIVITY BY ORGANISMS IN EXPERIMENTAL MARINE ENVIRONMENTS

T.W. DUKE, U.S. Dept. of Interior, Radiobiological Lab. , *Beaufort, North Carolina* 28516

The ultimate purpose of laboratory experiments on the uptake, accumulation, and retention of radionuclides from sea water by marine organisms is to collect sufficient data to be able to anticipate the dangers from any intentional or accidental pollution of an estuary or the oceans. To have some assurance that predictions concluded from results of laboratory experiments will be valid, it is necessary that laboratory data be compared with data collected as nearly as possible under field conditions. This, it is believed, can be accomplished by comparing laboratory findings with results obtained on the accumulation of radionuclides by communities of organisms held in large tanks or in ponds.

Research activities include experimentation in the laboratory and in the field. Laboratory experiments are being conducted with communities of marine organisms maintained in large tanks (1000-liter capacity) and exposed to flowing sea water containing various radionuclides including zinc-65, iron-59, iodine-131 and cesium-137. Also, a marine community composed of oysters, clams, fish, snails, crabs, algae, and marsh grass was placed in a shallow salt water pond and exposed to zinc-65 and chromium-51. Organisms, sediments, and water are being removed periodically, their radioactive content measured, and then returned to the pond. Upon completion, samples will be analyzed for total element so that the specific activity of the components in the pond can be determined. Data obtained in such experiments also will be useful in determining the trace metal requirements of various marine organisms.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0912, MEASUREMENT OF RADIONUCLIDES IN ESTUARINE AND MARINE ENVIRONMENTS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)

D.A. WOLFE, U.S. Dept. of Interior, Radiobiological Lab. , *Beaufort, North Carolina* 28516

Many scientists have been concerned with the potential effects on marine organisms of low-level radioactive wastes from nuclear reactors on land as well as those on ships and submarines. Additionally, fission products from nuclear weapons are now found in the biosphere. To evaluate the ecological effects of radionuclides on organisms of commercial importance, it is necessary to know the quality, quantity, and form of radionuclides in estuarine and marine environments. These data are needed now so they can be utilized to establish base lines for existing levels of radioactivity in various components of estuarine and marine ecosystems, and so the mechanisms of uptake in the passage of radionuclides through food chains can be investigated.

Large samples of biological materials (1 kg.) are collected for analyses. These samples are either dry ashed or wet ashed to reduce the volume and to provide homogeneous samples. The gamma activity of the samples is then measured with a low background detection system consisting of a multichannel analyzer and a 4 x 4-inch sodium iodide crystal-detector housed in a 7-ton shield. The data for each sample are stored on binary-coded punched tapes which can be used in a computer for comparisons with the radioactivity of future or past samples.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0913, OPTIMUM ECOLOGICAL DESIGNS FOR ESTUARINE SYSTEMS OF NORTH CAROLINA

H.T. ODUM, Univ. of North Carolina, Inst. of Marine Science, *Chapel Hill, North Carolina* 27514

This project will provide information on the feasibility of establishing associations of organisms in estuaries which can process man's wastes, metabolize inflow, develop the missing loops of the mineral cycles, and channel the fertility into one or more populations with food potential. Nine marine ponds will be constructed in a high marsh area along the coast of North Carolina. Three of the ponds will be continually seeded with mixtures of marine organisms (larvae, adults, plankton, micro-organisms, etc.) and will receive a steady flow of urban waste mixed with sea water. Three ponds will be seeded, but will be supplied only with sea water, i.e., no wastes. The remaining three ponds will receive the wastes mixed with sea water, but will not be seeded artificially.

Principal populations, some principal nutrient cycles and the total photosynthetic production and system respiration will be measured. Those populations of larger organisms which develop in large mass will be studied for growth rate and not production per area of meat potential.

SUPPORTED BY U.S. National Science Foundation

5.0914, EVALUATION OF HABITAT ALTERATION, CURRITUCK SOUND

T.E. CROWELL, State Wildlife Resources Comm. , *Raleigh, North Carolina*

The objective of this job is to record the extent of habitat alteration that results from the influx of salt water and/or turbidity to Currituck Sound during the Fiscal Year and to evaluate the resulting effects upon the game-fish resources.

Particular emphasis will be placed upon the drainage of artificially maintained salinities out of Back Bay and upon such saltwater intrusions as may result from natural, storm initiated, breaks through the Outer Banks.

The work outlined under the preceding Jobs I-A to I-G, inclusive, concerns the recognition of habitat changes and estimating their effects upon separate facets of the Currituck Sound flora and fauna.

The subject job represents, in essence, an integration of all of the individual considerations into one comprehensive analysis of the combined direct and indirect effects of habitat alteration upon the game fish.

The procedures employed will involve an integrated consideration of the net effects upon the game-fish resources resulting from the interaction of the various individual effects of habitat alteration after the latter have been estimated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
North Carolina State Government

5.0915, CHANGES DURING EUTROPHICATION OF AN ESTUARY

D.B. HORTON, Univ. of North Carolina, School of Agriculture, *Raleigh, North Carolina* 27600

To measure quantitatively the effects of the pollutants and the ensuing eutrophication on the communities of the plankton, rooted aquatic plants, and the macrobenthos, and to determine the factors that influence the distribution and abundance of the various species. 2. To predict the effects of even greater pollution of this estuary and, if possible, to make suggestions to alleviate the eutrophication. 3. To demonstrate the value of field plot design for understanding the biology of an estuary and for predicting effects of a pollutant. 4. To determine if a measurement of the heterotrophic activity of the planktonic bacteria with radioisotopes is a useful method of indicating the degree of eutrophication and pollution.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
North Carolina State University
North Carolina State Government

5.0916, RESEARCH IN MARINE BENTHIC ECOLOGY OFF OREGON

A.G. CAREY, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

The distribution, abundance, and ecology of the large and small marine benthic macrofauna off Oregon are being studied to define interrelationships of the benthic fauna with their environment. A line of stations across the continental shelf, continental slope, and Cascadia Abyssal Plain has been sampled repeatedly with trawl, dredge, and grab to a depth of 3000 meters and a distance of 322 kilometers offshore. The fauna shows a layered distribution, many species being limited to a narrow depth range. Six depth zones exhibit transitions from one animal assemblage to another. These transitional areas are generally associated with changes in sediment type, one of the complex of environmental factors affecting distributions. The benthic invertebrates are most abundant beyond the edge of the shelf at 225 meters; a slightly smaller peak in abundance occurs inshore at 25 meters.

SUPPORTED BY U.S. National Science Foundation

5.0917, MARINE ECOLOGICAL STUDIES

J.W. HEDGPETH, Oregon State University, Graduate School, *Corvallis, Oregon* 97331 (N00014-67-A-0369-0001)

This is a program of long-term observations on populations of intertidal and shallow water marine invertebrates of the Oregon Coast. Investigations are being made into the effects of environmental fluctuations on these populations. The continuous recording of intertidal water and air temperatures on a rocky shore, never previously attempted, are made to provide essential data for understanding environmental stresses that influence distribution, abundance and reproduction of marine organisms. Studies of organisms at the recording stations and at standard plot sites are to coincide with the continuous record.

Hydrobiological data such as these can lead to better understanding of the interrelationships among the biological, physical, chemical, and geological components of marine environments. This understanding is essential for the development of more efficient and effective techniques for the control of and/or protection against marine life whose presence or absence are of operational significance to the Navy. Biological fouling and deterioration, modification of beach conditions, and bottom sediments are examples.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0918, EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS

R.E. MILLEMANN, Oregon State University, Agricultural Experiment Sta. , *Corvallis, Oregon* 97331

1. To evaluate, through short-term bioassays, the acute toxicity to certain estuarine organisms of the insecticide Sevin. 2. To determine the effects of Sevin on a community of organisms in artificial mud flats. 3. To follow the residual life and metabolism of Sevin in estuarine organisms and in their environment. 4. To study compounds related to Sevin, as well as other pesticides, in the above manner.

SUPPORTED BY Oregon State Government

5.0919, EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS

R.E. MILLEMANN, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

Studies are continuing on the establishment of a well-balanced community of organisms in laboratory models of an estuary. The chronic effects of Sevin and other pesticides on members of such communities will be studied. Studies are in progress on the effects of the insecticides Sevin and Dursban on the survival, growth, and reproduction of the Dungeness crab, the viviparous shiner perch, and the oviparous chum salmon. Biochemical studies on the modes of action of Sevin and its metabolites on estuarine organisms are continuing.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0920, BIONOMICS OF FISHES AND SHELLFISHES

C.E. WARREN, Oregon State University, Agricultural Experiment Sta. , *Corvallis, Oregon* 97331

To: obtain bionomic information of important fishes and shellfish species of Oregon bays in relation to ecological factors (temperatures, salinities, currents and tidal phases, pH, dissolved oxygen, carbon dioxide, turbidity, edaphic conditions, folds, industrial and domestic sewage wastes, etc.); continue development of aqua-culture procedures for oysters, clams and other marine species of importance, particularly rearing of free-swimming larval stages of oysters and clams to seed stage; and, obtain reliable biological information as to resistance and susceptibilities of marine organisms to various pollutional conditions occurring in marine waters and provide methods and scientific data for predicting effects on marine organisms and for establishments of water quality criteria for marine areas.

Description of Work: Perform bioassays with various toxic effluents commonly discharged into marine waters using fishes and the several life stages of oysters and other marine organisms as test animals; and perfect the mussel embryo-larval bioassay techniques for quickly assessing the toxic components of effluents discharged by wood- processing industries into bays and estuaries.

Continue oyster culture studies, particularly the rearing of pelagic larvae of the Kumamoto oyster to 'seed' stage under controlled laboratory conditions; and begin preliminary studies on the damages and control of mud-shrimps to oysters.

SUPPORTED BY U.S. Dept. of Agriculture
Oregon State Government

5.0921, THE ENVIRONMENTAL REQUIREMENTS OF MARINE PLANKTONIC ORGANISMS

J.C. PRAGER, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab. , ***Wakefield - Kingston, Rhode Island*** 02881

This study is concerned with obtaining marine planktonic organisms in culture and the developing of methods for the mass culturing of these organisms. Also included are studies to determine the environmental requirements of marine planktonic organisms in relation to nutrients, temperature, pH, salinity, and light quantity and the physiological responses of lower marine forms to environmental changes.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0922, ENVIRONMENTAL CONDITIONS AND POPULATION DYNAMICS IN SELECTED UNPOLLUTED ESTUARIAL AND COASTAL AREAS

C.M. TARZWELL, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab. , ***Wakefield - Kingston, Rhode Island*** 02881

When the full research program is under way, laboratory studies will be made for the determination of the environmental requirements of marine organisms and levels of potential toxicants which are acutely toxic and those which are not harmful under conditions of continuous exposure. These laboratory findings are to be field tested. It is proposed to make these tests in pilot areas or in areas which are controlled but resemble the natural environment or in areas where the environment is essentially natural. It is planned to introduce these toxicants at the selected levels in such areas and to keep their concentrations at a constant level in order to determine their effects on the biota under conditions of continuous exposure. In order to evaluate these effects, the environmental conditions and the populations and the relative abundance of the different organisms under natural conditions must be known. It is proposed to begin a study in the immediate future to serve as such a baseline, so that changes due to potential toxicants or changes in environmental conditions may be evaluated.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0923, HISTOLOGICAL, HISTOCHEMICAL AND HISTOPATHOLOGICAL EFFECTS OF WATER POLLUTANTS ON MARINE ORGANISMS

P. YEVICH, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab. , ***Wakefield - Kingston, Rhode Island*** 02881

The National Marine Water Quality Laboratory has as its function, the collection of data essential for the development of water quality criteria for the protection of aquatic life and other uses. To secure this data, research must be carried out to determine (1) the levels of potential toxicants which are acutely toxic and those which are not harmful under conditions of continuous exposure. Several disciplines will be utilized in this work, including histology, pathology, toxicology, exzymology, biochemistry, etc. In this project, it is planned to determine the effects of sublethal and very low levels of toxicants on important marine organisms through histological, histochemical and histopathological studies. In order to do this effectively and efficiently, the normal histology of these organisms must be known. Therefore, before the completion of the main laboratory, studies of the histology of so-called normal organisms in unpolluted areas are being initiated to serve as a baseline of comparison for evaluating the effects of sublethal levels of potential toxicants. A library of slides will be built up showing the natural or normal condition for all important marine organisms in the shore and estuarial areas. It is expected that this project will get underway in Fiscal Year 1967 and will continue for a number of years.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0924, EFFECTS OF CRUDE OILS AND THEIR EMULSIONS TO MARINE ORGANISMS

R. EISLER, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab. , ***West Kingston, Rhode Island*** 02892

Oil discharges at sea, especially accidental discharges by super- tankers, represent a potential threat to aquatic life. Laboratory bioassays on the acute toxicity of different grades of crude to various species of marine fishes and crustaceans are now in progress. The effect on toxicity of emulsifying or complexing the oil with various chemical agents is being investigated.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0925, BIOLOGICAL COLONIZATION OF A RECENTLY FORMED ISLAND

B. MAGUIRE, Univ. of Texas, Graduate School, ***Austin, Texas*** 78712

Analysis of rate and pattern of colonization of fresh waters on the recently formed volcanic island, Surtsey, will give new insight into some of the processes and interactions which determine the biogeography of islands. Information gained by the analysis of the communities as they develop should permit increase of our understanding of : 1. The process and pattern of community development when its greatest limitation is the rate of arrival of potential participants, 2. Some aspects of the ecology of colonizing species which relate to their successful transport to and invasion of the water in the tubs, 3. The inter-relation between dispersal rates to island communities and the rate at which previously successful colonizers are eliminated, 4. The nature and relative stability of the communities which occur at equilibrium or near equilibrium conditions in this kind of small, isolated habitat, and 5. The mechanisms of passive dispersal of small aquatic organisms. Dilution and enrichment experiments should give information concerning the number of resting stages of various species which are present but not taking part in the active community at the time of collection. Interpretation of the seral stages which follow both dilution and enrichment should provide information concerning the importance of the process of succession in production of community structure observed and hopefully also will permit increased insight into the nature of the successional process itself.

SUPPORTED BY U.S. National Science Foundation

5.0926, A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY

R.J. BALDAUF, Texas A & M University System, School of Agriculture, ***College Station, Texas*** 77843

The Galveston Bay System of Texas serves as an essential nursery area for commercial shrimp and certain fishes. The System serves in this capacity because of the discharge of fresh water from the Trinity River and the subsequent mixing of this water with the saline waters of the Gulf of Mexico. Available data suggest that a reduction in the flow of water will cause the System to become more saline and thus unable to serve as a nursery area.

The Texas Basins Project, the proposed dredging of the Trinity River for navigation, and the current construction of the Wallisville Dam just above the Trinity River Delta will influence the chemical, physical, and biological conditions of the System. The purpose of this project is to determine the nature of this influence.

Samples of fishes, crustaceans, and water will be collected from above and below the proposed site of the Wallisville Dam to determine (1) the chemistry of the water, (2) the fish and crustacean fauna, (3) the salinity tolerances of the animal species collected, (4) the role of a dam on the flow of nutrients into a major bay system, and (5) the population dynamics of the fauna.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
Texas A. & M. University System

5.0927, THE EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ON BEEF CATTLE PRODUCTION, PLANT

5. LIVING SYSTEMS (NON-HUMAN)

ECOLOGY, SOIL PRODUCTIVITY, AND ESTUARINE ANIMALS

J.C. SMITH, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843

Objectives: (1) To determine the nature and extent of loss in beef production of Hereford, Brahman and Braford cattle from high infestations of salt-marsh mosquitoes (Aedes sollicitans and Aedes taeniorhynchus), (2) Ascertain the feasibility of chemical control of mosquitoes for beef cattle production, (3) Determine the effectiveness of physical methods of mosquito abatement (water management) in salt- marsh pastures, (4) Determine the effect of physical control practices on soil structure and productivity, on plant species, and on estuarine animals.

Procedure: Obj. in the salt-marsh and each pasture stocked with three breed of cows. Chemical mosquito control will be maintained on two pastures with the other two pastures left as a control. The animals will be individually sprayed in one treated pasture and one control pasture. Periodic weights, calving percentage, and milk production records will be maintained on the cows. Periodic and weaning weight and carcass quality will be recorded on the calves. Mosquito counts will be made on both light trap collections and selected animals from each group to measure mosquito population. Obj. bay will be surveyed for elevation and a main lateral ditch cut from the lowest depression into the bay. Feeder laterals will be cut from the minor depressions to the main lateral ditch to permit free water movement by tidal action. Mosquito population, plant and soil studies, estuarine animal studies, pasture fertilizer, weed 028 control and pasture management will be evaluated in this phase of the program.

SUPPORTED BY Texas State Government

5.0928, ECOLOGY OF WESTERN GULF ESTUARIES (ESTUARINE PROGRAM)

W.L. TRENT, U.S. Dept. of Interior, Biological Laboratory, *Fort Crockett - Galveston, Texas*

Demands upon water resources along the coast of Gulf of Mexico are rapidly altering the estuaring environment. These combined alterations disturb the integrity of large estuaries to the extent that entire biological systems may be significantly affected. Basic to an evaluation of the effects of estuarine alteration is knowledge of the inter-relations of factors, such as nutrients, bottom types, marine organisms, and vegetation.

Project objectives are to (1) compare the productivity of natural estuarine habitats with areas altered by dredging, spoiling, bulkheading and filling; (2) determine practical methods for rehabilitating altered habitats so that productivity can be reestablished; and (3) determine management procedures for maintaining or increasing the productivity of estuarine areas.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0929, BIOLOGY-MIDDLE EAST WATERS

J.S. PEARSE, Amer. University At Cairo, *Cairo, United Arab Republic* (N62558-5022)

The proposed research is designed to delineate life cycles and reproductive periodicities of selected marine organisms of the Red Sea, Gulf of Suez, and the Suez Canal. These waters, even though relatively small in volume, span from tropical to north temperate latitudes; and consequently, the common widespread tropical Indo-Pacific species native to this area are subjected to varying degrees of seasonal temperature change. The investigator will compare breeding frequencies of tropical area versus north temperate area populations of the same species in an attempt to determine what environmental factor(s) are responsible for the synchronization of reproductive development within a population or possibly within a particular species.

The Middle East Indo-Pacific waters are areas where there are pronounced deficiencies in biological and environmental data. It is essential that information on normal fluctuations in population composition and abundance be obtained, in order to predict the effect of the biological and environmental parameters.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0930, SEASONAL DISTRIBUTION AND ABUNDANCE OF DEMERSAL FISH AND INVERTEBRATES IN THE MARINE WATERS ADJACENT TO THE MOUTH OF THE COLUMBIA RIVER

D.L. ALVERSON, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Seattle, Washington* (AT(49-7)1971)

A continuing cooperative investigation between the AEC and the Bureau of Commercial Fisheries has been carried out in the marine area adjacent to the Columbia River mouth since 1961. The objectives of the investigation are to (1) determine on a seasonal basis the composition, distribution, and relative abundance of marine resources inhabiting these waters, and (2) assist in the evaluation of the role that the bottom animal community plays in the biological transport of radionuclides by providing samples of various bottom dwelling animals for radiological analysis by the Radiation Ecology Laboratory at the University of Washington.

The relative abundance of fish in this area ranged from a high of about 5,000 pounds per hour of trawling at depths of 50 fathoms to 100-300 pounds per hour of trawling at depths greater than 500 fathoms. Invertebrate catch rates were lower, being greatest at depths from 100-375 fathoms where they averaged 100-250 pounds per hour of trawling. The investigation has also shown that commercially utilized forms of fishes, such as sablefish, inhabit depths at least to 600 fathoms, and that several forms such as Tanner crabs, Pacific ocean perch, and sablefish undergo seasonal bathymetric movements. In addition, other commercially utilized species, such as Pacific hake and Dover sole, carry out north and south seasonal migrations in the study area. A study of the feeding habits of the Pacific hake, the dominant higher level forage species in the outfall area, has established that this species feeds primarily on euphausiid shrimp, a form important in the uptake of 65Zn. The above results represent steps leading toward an eventual understanding of the radionuclide budget in the marine area adjacent to the Columbia River mouth with an assessment of the magnitude of the total radioisotope load imposed on the system by the atomic reactors at Richland, Washington. Knowledge gained as to size and composition of the deep-water fish and invertebrate populations will also be helpful in appraising deep-water dumping sites.

SUPPORTED BY U.S. Atomic Energy Commission

5.0931, ANNUAL PHYTOPLANKTON PRODUCTION IN PUGET SOUND WATERS

G.C. ANDERSON, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

Studies of phytoplankton production are being continued in Puget Sound. The investigation, since 1964, has provided quantitative information on annual phytoplankton production and mean standing crop in two areas of the Sound.

The research proposed herein is to elucidate the reasons for the very large blooms off Seattle when maximum values of 6-7 g C/square meter are photosynthesized per day. Weekly, daily and diurnal sampling will be carried out during periods of high phytoplankton production along with measurements of hydrographic conditions, light and nutrients. Particular attention will be given to the effect of stability, as affected by tides and winds, on the timing of phytoplankton blooms. Measurements will be made of the chemical composition of the crop as well as growth rates of dominant species.

Experimental work involving studies of phytoplankton blooms in enclosed columns of water in situ will be carried out. In this manner, the effects of advection will be eliminated. Culture studies will be conducted with some of the herbivorous copepods.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5I. PRODUCTIVITY - BIOCHEMISTRY

(food Chains, Primary Productivity, Laboratory Studies ofReproduction, Cytology, Physiology, and Behavior.)

5.0932, PHOTOBIOLOGICAL STUDIES ON MARINE CHRYSOMONADS

M.B. ALLEN, Univ. of Alaska, Graduate School, *College, Alaska* 99735

This research is to continue studies on the phosphorylation and electron transport system of Hymenomonas chloroplasts. These have previously been shown to carry out active cyclic photophosphorylation with phenazine methosulfate (PMS), but not to possess appreciable activity when FMN or vitamin K compounds are used as cofactors, nor to be capable of non-cyclic photophosphorylation with NADP or ferricyanide. Since the chloroplasts retain a high degree of overall photosynthetic activity, it seems unlikely that these results are due to a deficiency in the oxygen evolving system. The reasons for this difference from green plant chloroplasts will be investigated and the ability of the chloroplasts to carry out various other light driven electron transport reactions will be explored.

An attempt to isolate the organelle with the finely coiled lamellar structure and determine its composition and metabolic activity, if any, will be made. The marine chrysomonads are generally considered to be a group of organisms in which many evolutionary experiments have taken place, and the possibility exists that this organelle represents a vestige of some experiment with chloroplast structure. On the other hand, structures appearing somewhat similar in the electron microscope have been observed in photosynthetic cells. In these cells, it has been proposed that the structures are digestive organelles. Possible relations with the coccolith forming system must also be considered, since such a function has previously been suggested.

SUPPORTED BY U.S. National Science Foundation

5.0933, DYNAMICS OF THE NITROGEN CYCLE IN THE SEA

J.J. GOERING, Univ. of Alaska, Graduate School, *College, Alaska* 99735

This is an investigation into several aspects of the marine nitrogen cycle using 15N tracer techniques. The major emphasis is on measurement of in situ rates of nitrogen fixation, nitrate, ammonia, and amino acid assimilation, nitrification, and dentrification.

SUPPORTED BY U.S. National Science Foundation

5.0934, ABUNDANCE AND MIGRATION STUDIES OF THE WHITE SEAPERCH (P. FURCATUS), PILE PERCH (R. VACCA), STRIPED SEAPERCH (E. LATERALIS) AND STARRY FLOU

A.J. BEARDSLEY, U.S. Dept. of Interior, Tiburon Marine Lab., *Belvedere - Tiburon, California* 94920

Objective: 1. To study the movements and possible migrations of the four recreationally important species in Yaquina Bay, Oregon, in relation to environmental factors. 2. Estimate the abundance by angler yield of these species.

Procedures: Species to be studied are the white seaperch (Phanerodon furcatus), pile perch (Rhacochilus vacca), striped seaperch (Embiotoca lateralis) and the starry flounder (Platichthy's stellatus). Intra-estuarine and coastal movements of these fishes will be determined by analysis of tag recoveries. Yaquina Bay will be divided into nine geographical areas for sampling purposes. Environmental data (tide, temperature, salinity) will be taken at each trawl sampling station. Estimates of population will use the capture-mark-and-recapture technique.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0935, STRUCTURE AND FUNCTION OF CELL ORGANELLES DURING GROWTH AND DEVELOPMENT

M. ALFERT, Univ. of California, Graduate School, *Berkeley, California* 94720

The structure of the nucleolus and nucleolar-like bodies, and their role in ribosome formation in Urechis are being studied; attempts will be made to hybridize ribosomal RNA to DNA of the nucleolar organizer of fixed plant cells in situ. The structure of the Urechis acrosome and the formation, characterization and function of acrosomal basic protein are being studied. The onset and termination of nuclear basic protein synthesis in relation to DNA synthesis in unfertilized eggs of Urechis and its effect on early development will also be studied--cytochemical, biochemical and electron microscopic techniques will be used in these investigations.

SUPPORTED BY U.S. National Science Foundation

5.0936, STRUCTURE AND FUNCTION OF CELL ORGANELLES DURING GROWTH AND DEVELOPMENT

M. ALFERT, Univ. of California, Graduate School, *Berkeley, California* 94720

The structure of the nucleolus and nucleolar-like bodies, and their role in ribosome formation in Urechis are being studied; attempts will be made to hybridize ribosomal RNA to DNA of the nucleolar organizer of fixed plant cells in situ. The structure of the Urechis acrosome and the formation, characterization and function of acrosomal basic protein are being studied. The onset and termination of nuclear basic protein synthesis in relation to DNA synthesis in unfertilized eggs of Urechis and its effect on early development will also be studied--cytochemical, biochemical and electron microscopic techniques will be used in these investigations.

SUPPORTED BY U.S. National Science Foundation

5.0937, UPTAKE AND ASSIMILATION OF ORGANIC COMPOUNDS IN MARINE ORGANISMS

G.C. STEPHENS, Univ. of California, Graduate School, *Irvine, California* 92664 (N00014-67-A-0323-0001)

The investigator is attempting to determine the role of dissolved organic matter in the nutrition of organisms and in the total economy of the sea. Results of studies by others have not been definitive on this important subject, although the investigator's laboratory has established the ability of soft-bodied invertebrates to remove amino acids and other small organic molecules from dilute solutions characteristic of natural waters. He is conducting laboratory and field studies to determine the mechanism of uptake and assimilation of the organic matter, the metabolic fate of the compounds, and to assess the potential contribution of this process to the total nutrition in the sea.

Since it is unlikely that any areas of the sea are completely sterile for long, and since many Navy problems are caused by biological agents, it is important to determine the basic factors which influence the distribution and abundance of organisms.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0938, UPTAKE OF ORGANIC COMPOUNDS BY MARINE INVERTEBRATES

G.C. STEPHENS, Univ. of California, Graduate School, *Irvine, California* 92664

A number of soft-bodies marine invertebrates are capable of removing small organic compounds from solution in the ambient medium. This has been established for almost 100 genera in 11 phyla. The present project is designated to explore the potential significance of the process: a. as a source of nutrition, b. as a source of specific required dietary constituents, and c. as a source of information for the organisms.

The project is also designed to exploit the capability of pulse labelling the free amino acid pools of the organisms studied in order to study their metabolism. Finally, we propose to study the mechanism of uptake of small organic compounds.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0939, PHYSIOLOGY OF MARINE ORGANISMS

R. LASKER, U.S. Dept. of Interior, Fishery Oceanography Ctr., *La Jolla, California*

This project deals with the study of energy budgets of important food fishes and of the organisms on which they depend for their food. Primary attention has been directed both to the utilization of food during assimilation and to the measurement of quantities required for growth, maintenance activities, and reproduction from the egg to the adult. Important physiological aspects such as osmoregulation and salinity tolerance, digestion, chemoreception, and rates of development are also studied under different environmental variables such as light, salinity, and temperature.

It is further planned to study the requirements of larval fish after the critical period of yolk resorption and to carry these and other studies to sea in the Center's new research vessel, David

Starr Jordan, where it will be possible to measure these requirements under the most realistic experimental situations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0940, PRODUCTIVITY MEASURES

P.E. SMITH, U.S. Dept. of Interior, Fishery Oceanography Ctr., *La Jolla, California*

In order to assess the abundance and availability of commercial fish stocks, it is necessary to understand the food chain in the sea which begins with the primary production of phytoplankton and proceeds through many complex steps to the production of fish. Comprehensive data on physical oceanography and primary biological production, accumulated over many years of survey cruises, are available from the California Current area but better information is needed on the composition and distribution of the zooplankton and nekton, higher in the food chain.

Present studies on zooplankton abundance in the California Current will be continued to include the development of more precise sampling techniques and methodology. Computer analysis of past zooplankton data is nearly complete and the results will be used to improve the efficiency of future surveys. Nekton distribution and abundance will be assessed by two independent methods; one will be a limited number of tows with standard trawl gear and the other, more extensive method, will be standard transects with sounder and sonar acoustic apparatus.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0941, STUDIES OF PROTEINS UNDER EXTREME ENVIRONMENTS

J.K. LANYI, U.S. Natl. Aero. & Space Adm., Ames Research Center, *Moffett Field, California* 94035

OBJECTIVE a. Problem - To study the biological, physical-chemical and structural properties of proteins, enzymes and membranes which function at concentrations of salt so high as to be normally incompatible with life. b. Application - To provide a basis for understanding life processes possibly present in extraterrestrial situations. c. Identification of the components of the membrane-bound respiratory chain, study the effects of the presence and absence of salt on substrate-protein and protein-protein interactions. Exploration of the unique features of proteins in halophiles which require salt.

APPROACH: Spectrophotometric and polarographic study of the oxidation and reduction of cellular components. Use of inhibitors and redox dyes in identifying pathways of electron transfer. Fractionation and individual study of some of the enzymes involved.

PROGRESS: Reporting period 04 67 to 04 68. The cytochromes of H. cutirubrum have been identified by their pyridine hemochromogen spectra and by their functional relationship to various reduced substrates. It was found that at neutral pH all electron flow passes through cytochromes b559, c555 and a592. At higher pH, however, an alternate pathway operates as well which consists of cytochromes b563 and c550. The alternate pathway shows different salt dependence than the main pathway and is inactivated on overnight incubation. Two publications on this work are being submitted to Archives of Biochemistry and Biophysics: 'Studies of the Electron Transport System of Extremely Halophilic Bacteria. I. Spectrophotometric Identification of the Cytochromes in H. cutirubrum, and II. Salt Dependence of Cytochrome b563.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

5.0942, POLYPEPTIDE INTERACTIONS ON A STERILE SEASHORE

H.H. PATTEE, Stanford University, Graduate School, *Palo Alto - Stanford, California* 94305

This work is one approach to the general origin of life problem. We assume two working hypotheses: (1) On the primitive earth there was established a sterile irreversible, multi-phase ecocycle which provided the primary materials and reaction processes to condense and degrade copolymers, and (2) in this complex environment, one necessary condition for the origin of life is the occurrence of specific catalytic control of monomer sequence in copolymer synthesis. One set of experiments is designed to demonstrate a possible geochemical cycle for carbon and nitrogen passing through copolymer synthesis and degradation. Synthesis of many biological monomers such as amino acids has already been demonstrated. We have studied the degradation of the large amounts of nearly intractable melanine-like material which probably requires continuous deposition on silica beaches, exposure to ultraviolet radiation from 1800-2000 angstroms, and return of soluble products to the sea. A second set of experiments is designed to find reasonable condensation reactions for amino acids in the sea, and catalytic monomer ordering constraints resulting from heterogeneous reactions occurring at interphase boundaries on foams, emulsions or particles. Theoretical studies on the ordering of copolymer sequences and the origin of hereditary codes is being simulated by computer programs.

SUPPORTED BY U.S. National Science Foundation

5.0943, PRESSURE EFFECTS ON MARINE ORGANISMS

H.A. LOWENSTAM, Calif. Inst. of Technology, Graduate School, *Pasadena, California* 91109 (NONR)

Studies will be continued on the biochemistry and physiology of organisms collected from deep ocean waters. Organisms will be collected from various depths in the ocean and maintained in open flow, high pressure vessels at preselected pressures and studied with regard to such factors as viability, growth rates, and nutritional requirements. During these studies, research will be continued on the design and development of more advanced culture equipment and techniques pertinent to maintaining living deep sea organisms under high pressures.

It is becoming more apparent that deep ocean environments represent areas of vital importance to Naval operations. Little knowledge of any aspect of these waters has been obtained by direct observation. Present concepts are based largely on predictions and extrapolation from shallower waters and from very few actual samplings. Although historically thought to be a biological desert, the deep oceans are now known to be populated by a moderate number of organisms, but representing a relatively large number of species and displaying many bizarre characteristics.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0944, CAROTENOIDS, CAROTENOID CHROMOPROTEINS, AND ASSOCIATED LIPIDS IN ANIMALS

D.L. FOX, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

Comparative biochemical studies of the metabolic fractionation of carotenoids and associated pigments in marine and other aquatic animal phyla (e.g. sponges, coelenterates, worms, crustaceans, mollusks, echinoderms, fishes and birds), with special reference to (1) selective assimilation of unchanged food-carotenoids; (2) complete destruction or partial oxidation of some of these, e.g. into alcoholic or ketone derivatives; (3) relative quantities of various carotenoid fractions stored; (4) disposition as carotenoid chromoproteins, e.g. in certain nudibranch mollusks and asteroid echinoderms, and the possible physiological bearing of carotenoids, e.g. in photokinesis of animals.

Melanins, naphthoquinones and tetrapyrrols (porphyrins and bilins) are of common incidence, and may call for some special attention in certain animals.

Studies such as these are sometimes found to be significant in supporting certain morphological differences between species or subspecies of a common genus. In other instances, a single species within a lower evolutionary group, such as the plumose anemone, Metridium, may involve considerable flexibility in its metabolism of colored molecules.

SUPPORTED BY U.S. National Science Foundation

5.0945, STUDIES ON EMBRYONIC CELLS

G. FREEMAN, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

Two separate but related projects are underway designed to answer the question: How does a population of embryonic cells maintain its quality of being embryonic? One project is a study of the cellular basis for asexual reproduction in Tunicates, and the other a study of the developmental potential of cell cultures of unincubated chick blastoderm cells.

The ascidians (sea squirts) can reproduce asexually in a variety of ways. There are at least two other embryonic populations in addition to the embryonic cell population of the blood that can provide a cellular basis for asexual reproduction. The histological studies which have been done on asexual reproduction and regeneration in this genus indicate that during asexual reproduction only one embryonic cell population, the lymphocyte cell class, provides the cellular basis for a new bud formation. During regeneration of the zooid, the other embryonic cell population, the epicardium, provides the cellular basis for new tissue formation. The epicardium is only found within the zooid proper while the lymphocyte cell class is found both in the stolon and in the zooid. The relationship between these two embryonic cell populations will be studied by making chimera between closely related species of Clavelina such that only the lumphocyte population of one species is present and only the epicardial cell population of the other species is present.

SUPPORTED BY U.S. National Science Foundation

5.0946, BIOCHEMICAL BASIS OF SPECIFIC CELL ASSOCIATION

T.D. HUMPHREYS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The arrangement of individual cells into a variety of specific groupings and architectural patterns characteristic of adult tissue is being investigated. Explanations of this cell order usually center around some ideas of cell surface reactions; such as specific cell adhesion which guides cells during morphogenesis. However, there has been little information on the mechanism by which the surfaces of cells interact with one another and the ideas invoking adhesive reactions in guiding cells during development have necessarily been speculative.

A system for isolation and analysis of the aggregation factor on the sponges available in the Pacific Ocean is being worked out. The information gained by the isolation of the cellular components involved in species specific aggregation of marine sponge cells suggests many experiments on the cells of higher organisms. To work out the problems of tissue dissociation and to demonstrate and characterize an aggregation factor, cells of early chick embryos will be used.

SUPPORTED BY U.S. National Science Foundation

5.0947, MARINE PHYSIOLOGY

P.F. SCHOLANDER, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

P. F. Scholander: Mechanism of osmosis and imbibition. Negative interstitial-tissue pressure. H. T. Hammel: Temperature regulation. Osmotic mechanism and ice formation. R. W. Elsner, D. L. Franklin, and G. L. Kooyman: Cardiovascular parameters in asphyxial defense mechanism during birth and diving. E. A. Hemmingsen: Supersaturation and Cavitation in biological liquids. Ultraviolet defense mechanism in cornea, in various animals. Respiratory and metabolic characteristics of Antarctic fishes. W. F. Garey: Permeability studies in gills. Sigmund Stromme: Negative pressure in interstitial fluids. A.A. Yayanos: Enzyme systems under high pressure. J. M. Wells, graduate student: Pressure effect on oxygen-hemoglobin dissociation curve. A. R. Hargens, graduate student: Osmosis and water transport in macro molecular systems.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0948, STUDIES OF THE EFFECTS OF NUTRIENTS ON THE GROWTH OF PHYTOPLANKTON IN THE TROPICAL PAC. OCEAN

W.H. THOMAS, Univ. of California, Inst. of Marine Resources, *San Diego - La Jolla, California* 92038

Algal cultures from the tropical Pacific Ocean have been established and their growth has been measured in various media and at several light intensities and temperatures. At optimum light and temperature levels, nutritional requirements are defined in terms of the effects of nutrient concentration on growth rates and final yields of both cultures and natural populations. To describe the relative fertility of various areas of the tropical Pacific, these nutrient requirements are compared with nutrient concentrations in sea water samples. To determine which nutrients are limiting, sea water samples have been enriched with various nutrients and the effects of enrichment on photosynthesis or chlorophyll synthesis have been measured. The degree of deficiency of natural populations will be defined by comparing various intracellular ratios and photosynthetic parameters - especially assimilation ratio - in populations from poor water with the same ratios and parameters in populations from rich water. These will be compared with the same ratios and parameters in cells grown in the laboratory at varying degrees of nutrient deficiency.

SUPPORTED BY U.S. National Science Foundation

5.0949, NUTRIENT STORES IN REPRODUCTION IN SEA INVERTEBRATES

M.A. NIMITZ, Dominican Coll. of San Rafael, Graduate School, *San Rafael, California* 94901

The aims of this investigation are fourfold: 1) to trace the reproductive cycles of two species of starfish (Patiria miniata and Pisaster ochraceus) and two crustaceans (Pachygrapsus crassipes and Emerita analoga) through monthly gonad index determinations of samples of 10 animals. 2) to determine the sites of lipid and carbohydrate nutrient stores in the tissues of each species by histochemical procedures, and to trace changes in the location (and quantity, in sofar as possible histochemically) of the reserves during the course of the reproductive cycle; 3) to determine the effects of a period of starvation coextensive with the normal period of gametogenesis on the quantity and quality of the gametes produced; 4) to gain as much information as possible on the distribution of acid and neutral mucopolysaccharides and proteins in the tissues of these animals.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0950, PHYSIOLOGY OF LUMINESCENT SIGNAL SYSTEMS

J.F. CASE, Univ. of California, Graduate School, *Santa Barbara, California* 93018 (N00014-67-A-0120-0002)

It is proposed to study, physiologically and behaviorally, the visual receptors of light producing marine and terrestrial animals to consider the development of their function as receptors of photic and other stimuli and their response mechanisms. The investigation will attempt to determine the biological significance of the luminescent systems and to examine the role of the environment in the operation of the systems.

The light producing behavior of many organisms serves as a means for quantitative detection of certain trace elements required for luminescence in some forms. Controlled production of light, when and where desirable, is possible and the proposed study will permit more effective control.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0951, BEHAVIOR AND SPECIFICITY IN MARINE SYMBIOSIS

D. DAVENPORT, Univ. of California, Graduate School, *Santa Barbara, California* 93018 (NONR)

Objective: The understanding of the responses of marine organisms to the physical environment and to one another is of direct importance to a wide range of problems encountered by the Navy in the marine environment. The presence or absence of organisms which are responsible for biodeterioration, bioluminescence, or bioacoustical problems as determined by a host of environmental factors about which little is known.

Approach: Interrelationships between symbiotic marine organisms are being investigated by researchers to determine what biochemical attractants may be produced by the animals, and what means are employed for sensing these chemicals. Attempts are being made to isolate the active principles.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0952, PALEOBTANICAL RESEARCH AT YALE UNIVERSITY

T. DELEVORYAS, Yale University, Graduate School, *New Haven, Connecticut* 06520

Studies on the development of reproducible enrichment techniques in continuous culture for the isolation of characteristic marine bacteria were completed. Within a certain range of dilution rates and concentrations of the limiting substrate, chemostat enrichments were successful. Experimental attempts to separate single species from mixed cultures of known composition showed that succesful or unsuccessful competition for the limiting substrate could be expressed by kinetic growth parameters of the individual species under given conditions. Species exhibiting low values of their growth parameters displaced species with relatively high values if the continuous culture was operated correspondingly at low dilution rates and/or low concentrations of the limiting substrates. This behavior is significant for the characterization of those microorganisms actually responsible for the degradation of organic materials in the sea under natural conditions.

Based on the determination of growth parameters, the studies on population dynamics were continued. Mixed pure cultures of marine and non-marine bacterial strains were grown in the chemostat at doubling times up to 100 hours and at various concentrations of limiting substrate. Predicted displacement times could be confirmed experimentally.

Techniques for studying sulfate reducing bacteria in steady state culture have been established. The kinetics of substrate-(sulfate) and product-(sulfide) limited growth were studied with the aim of detecting characteristic metabolic differences.

SUPPORTED BY U.S. National Science Foundation

5.0953, AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE

F.C. DAIBER, State Board of Game & Fish, *Dover, Delaware*

Objective: An evaluation of the effects of various types of marshland management on the diurnal and seasonal concentrations of phosphorus and nitrogen in tidal marshes.

Procedure: Water samples will be collected from managed marshes representing ditched, high-level impounded, low-level impounded, and old and new champagne pools. Collections from natural marshland will serve as the control. The ditched marsh will be represented by Canary Creek Marsh. All the other types of marsh mentioned will be located on the Murderkill Marsh.

Collections will be made every six hours for one 24-hour period at each area once a month. The collection dates will be at 3 or 5 week intervals to allow sampling of spring and neap tides. Water samples will be collected in 250 ml amber glass bottles with rubber stoppers. Salinities will be collected in translucent plastic bottles for later determination. Water temperature will be measured with a centigrade thermometer. A battery-operated field pH meter will be used to determine pH and redox potential. Time, weather condition and air temperature will also be recorded.

The distance from the laboratory to the Murderkill Marsh area and the time involved in travel requires that the investigators remain in the field during the 24-hour collection period.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Delaware State Government

5.0954, PRIMARY PRODUCTION AND DECOMPOSITION IN ESTUARINE WATER

H.D. PUTNAM, Univ. of Florida, School of Engineering, *Gainesville, Florida* 32601

The objective of the proposed research is to contribute to an understanding of the synthesis and decomposition of organic matter by primary producers in an estuarine environment. Studies will be conducted to estimate the productivity of certain red and brown algae which are part of the benthic community in the Waccasassa Estuary. Appropriate methods for measuring fixation of isotopic carbon by attached plants were worked out under grant No. WP-00678-03 which will be completed by this investigator August 31, 1967.

In addition an attempt will be made to define more clearly the limiting factors for primary production in the Waccasassa Estuary. Emphasis will be directed toward the interaction of chemical and biological factors.

Efforts also will be made to follow the decomposition of organic matter under anoxic conditions in estuarine sediments. These studies will be directed mainly toward the characterization of substrates which are involved in methanogenesis. The pool size of volatile fatty acids resulting from the breakdown of algae will be determined and efforts made to establish metabolic turnover rates of these components.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0955, PRIMARY PRODUCTIVITY

J.W. JOSSI, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab., *Miami, Florida*

Objectives: 1. To understand the biology of the primary producers in the sea and to predict times and places of high organic production. 2. To develop valid techniques for measuring the standing crop and production rates of the primary producers in the sea, in order to meet the objective stated above.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0956, INTERACTIONS OF MARINE NUTRIENT COMPLEXES

J.W. VANLANDINGHAM, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab., *Miami, Florida*

Objective: To clarify the nutritional roles of iron and phosphorus compounds within the framework outlined in the proposal.

A laboratory study of possible chemical and physical interaction of iron and phosphate compounds within the marine nutrient cycle. a. Study of the mechanism of such interaction, if found, using labelled compounds of 32P and 59Fe as chemical tracers. b. Study the relationship of such interactions upon ingestion and assimilation in phytoplankton using 32P and 59Fe as chemical tracers.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0957, FORMATION AND UTILIZATION OF TERPENES

D.G. ANDERSON, Univ. of Miami, School of Medicine, *Miami - Coral Gables, Florida* 33124

Isolated and purified zooxanthellae, intracellular symbions of gorgonians and other marine invertebrates, are used as a source for enzyme systems capable of converting isoprenoid intermediates into a series of sesquiterpene hydrocarbons, a macrcyclic diterpene lactone (porosin acetate), and other isoprenoid products. Formation of these compounds is followed radiochemically from a series of labeled substrates, including specific geometric isomers of farnesyl pyrophosphate.

The gorgonian - zooxanthellae symbiotic complex as also studied from the viewpoint of terpene synthesis and terpene utilization. Gorgonian species utilized include P. americana, P. porosa, and E. mammosa.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0958, DEVELOPMENTAL STUDIES OF SELECTED INVERTEBRATES

H.B. OWRE, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

Descriptive studies of the development of locally abundant, littoral invertebrates which are either potentially useful to man as experimental forms or as food, or are deleterious, are underway. The subjects are members of the phyla Coelenterata, Platyhelminthes, Annelida, Mollusca, Echinodermata and Hemichordata. Information is being accumulated on size at reproductive maturity, type of spawn, early developmental stages, hatching and subsequent development. In the coming year, work will be concentrated on coelenterates, e.g., the stinging hydroid Lytocarpus phillipinus and stinging coral Millepora alcicornis, annelids, pelecypod molluscs and echinoid and holothuroid echinoderms.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0959, RELATION OF ENVIRONMENTAL FACTORS TO THE PRODUCTIVITY OF ESTUARINE SEDENTARY FAUNA

P.A. BUTLER, U.S. Dept. of Interior, Biological Laboratory, *Sabine Island - Gulf Breeze, Florida*

The incidence of setting per square centimeter per seven days on asbestos-cement plates at one station in Santa Rosa Sound near Pensacola, Florida has been measured since 1949. Predominant fauna counted include barnacles, oysters and bryozoa. Concurrent data are collected on water salinity, temperature and tides. Meteorological data are available. All data are to be programmed for analysis. Continuing project.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0960, SONIC SENSITIVITY OF FISHES AND AMPHIBIA

B.A. WEISS, Univ. of South Florida, Graduate School, *Tampa, Florida* 33620

In this project, the relative roles of auditory and lateral line sensitivity will be investigated in selected fishes and amphibians through a shock avoidance technique in response to a stimulus tome of closely controlled characteristics. Additionally, the evolution of auditory receptors will be studied by use of late stage tadpoles and fully developed frogs. An attempt will be made to differentiate between the near and far fields in sonic reception by fishes.

Sound production and reception by aquatic organisms gains in importance as acoustic instruments become more discriminative through technical refinements.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0961, BIOSYNTHESIS OF BROMOPHENOLS IN MARINE INVERTEBRATES

R.B. ASHWORTH, Univ. of Georgia, Graduate School, *Athens, Georgia* 30602

During attempts to isolate luciferin from the marine hemichordate Balanoglossus biminiensis an interesting brominated compound was isolated and its structure identified by UV, IR, NMR, mass analysis and melting point data. The isolated hemichordate Balanoglossus biminiensis (10-15 mg. per organism) and is responsible for its peculiar odor which has been described as 'iodoform-like.' These worms, belonging to the family, enteropneusta, are distributed all over the world and comprise some twelve genera and fifty-odd species, at least three of which are luminescent. Although dibromophenol has been identified only in one species, all apparently synthesize the compound since all possess the same pungent odor. There is no evidnece to suggest any connection between luminescence and production of the compound.

It might be surmised that bromophenol production is simply a defense mechanism, but this does not explain the prodigious synthesis of the compound. It is also possible that dibromophenol serves as an intermediate in thyroxine production in invertebrates.

It is hoped that by setting up a large-scale collection program of Balanoglossus biminiensis and other related invertebrates that sufficient material can be collected to resolve the question as to whether bromophenol is produced in other families of marine invertebrates and if so, whether there is a relationship to thyroxine biosynthesis.

SUPPORTED BY U.S. National Science Foundation

5.0962, CHEMISTRY AND ENZYMOLOGY OF BIOLUMINESCENCE

M.J. CORMIER, Univ. of Georgia, Graduate School, *Athens, Georgia* 30602

This is a renewal of GB-3156. Studies on the sequence of chemical events leading up to light emission in several luminescent systems will be continued (i.e., the sea pansy, Renilla reniformis, a model peroxidase type luminescent system, luminous bacteria, and luminous earthworms (Diplocardia)). A detailed study of the enzymology of these processes and of the nature of the intermediates involved in these reactions will be made. Renilla luciferase has been purified about 100 fold and a partial separation of the 3, '5'-diphosphoadenosine (DPA)-linked activating enzyme from that of luciferase has been achieved. It is hoped to completely separate these activities and study the mechanisms of a recently discovered, DPA-dependent, sulfate-luciferyl sulfate exchange reaction. In addition, more Renilla luciferin will be isolated in order to complete structural studies. Isolation of a luciferase from a strain of bacteria that emits at a different wavelength than luciferase isolated from Ph. fischeri will be attempted and a comparison of the properties of the two enzymes will be made. Studies on the mechanism of the peroxidase-luminol-H2O2 luminescent system will be continued. It is hoped to correlate light production with one of the many enzyme complexes formed in this reaction. One of the new bioluminescent systems which will be studied is that of the large luminous earthworm, Diplocardia. A H2O2 requirement for this reaction has been demonstrated. Isolation of the luciferase and luciferin from Diplocardia is in process.

SUPPORTED BY U.S. National Science Foundation

5.0963, THE ROLE OF COPROPHAGY IN MARINE FOOD CHAINS

D. FRANKENBERG, Univ. of Georgia, Graduate School, *Athens, Georgia* 30602

This study will evaluate the hypothesis that fecal material plays a significant trophic role in marine food chains. The proposed research will seek answers to the following questions: 1. What kinds of marine animals, under what conditions, utilize fecal pellets as food; 2. How much organic matter is made available in fecal pellets of various marine organisms; and 3. What physical, chemical and microbiological changes occur in fecal pellets after excretion. Information pertaining to these questions will be sought for a variety of marine organisms representing a diverse spectrum of feeding and taxonomic types.

SUPPORTED BY U.S. National Science Foundation

5.0964, THE ROLE OF FECAL PELLETS IN MARINE FOOD CHAINS

D. FRANKENBERG, Univ. of Georgia, Graduate School, *Athens, Georgia* 30602

The proposed study will evaluate the hypothesis that fecal material plays a significant trophic role in marine food chains. The study will be conducted utilizing field and laboratory facilities of the Department of Zoology and the Marine Institute of the University of Georgia. This proposal summarizes the evidence leading to the hypothesis, and outlines studies designed to test it.

The proposed research will seek answers to the following questions: 1. What kinds of marine animals, under what conditions, utilize fecal pellets as food; 2. How much organic matter is made available in fecal pellets of various marine organisms; and 3. What physical, chemical and microbiological changes occur in fecal pellets after excretion. Information pertaining to these questions will be sought for a variety of marine organisms representing a diverse spectrum of feeding and taxonomic types. The utilization of fecal pellets as food will be studied in experiments in which the growth and ingestion rates of animals offered fecal pellets as food will be compared with similar rates of animals offered other food sources. The rate at which organic matter is made available in fecal pellets will be analyzed by determining the production rate and organic matter content of a variety of fecal pellets, and by comparing the percentages of ingested food convered into new tissue (ecological growth efficiency), feces, and metabolism for a variety of marine animals. The post-excretion changes in fecal pellets will be analyzed by experimentally determining the transport and destruction rates, the changes in chemical composition, and the changes in microbiological content of a variety of fecal pellets at various times after defecation.

5. LIVING SYSTEMS (NON-HUMAN)

SUPPORTED BY No Formal Support Reported

5.0965, FIELD EXPERIMENTS ON THE FLUX OF RADIONUCLIDES THROUGH A SALT MARSH ECOSYSTEM

L.R. POMEROY, Univ. of Georgia, Graduate School, *Athens, Georgia* 30602 (AT(40-1)-3238)

After some 12 years of work on the salt marshes of Georgia by a number of investigators, it is now possible to begin building models of the flux of materials through the system. A compartmental-diagram model, showing standing stock and flux of phosphorus has been constructed. This is now being transformed into a mathematical model suitable for computer simulation of events in the salt-marsh ecosystem. The model will be tested and refined by computer techniques. Deficiencies in our data shown by computer analysis will be remedied by additional, small-scale field and labortory work. Manipulation of the model simulating changes in flux and storage of phosphorus by various populations (compartments) will help us predict the effect of various natural and man-made changes on the ecology of salt marshes.

In its present primitive state our model tells us that the marsh grass, Spartina alterniflora, which is the dominant primary producer, is unusually important in the biogeochemistry of phosphorus in marshy estuaries. Spartina appears to be taking all its phosphorus requirements from subsurface, reduced sediments that would otherwise be a sink. This phosphorus is released into the water when the Spartina dies and decays, as most of it does. This process undoubtedly has great significance in maintaining high productivity in the estuary.

SUPPORTED BY U.S. Atomic Energy Commission

5.0966, METABOLISM OF MARINE ECOSYSTEMS

L.R. POMEROY, Univ. of Georgia, Graduate School, *Athens, Georgia* 30602

This research is concerned with secondary and tertiary stages in the food web of natural waters. The results of work on the previous grant indicate that much of the energy available to all organisms in the sea is consumed by microorganisms. These microorganisms are in part bacteria and in part flagellates and other heterotrophic protozoans. The latter appear to be of major importance in the regeneration of PO4 (and probably NH3 as well). The microorganisms of the open sea are to a considerable extent associated with the so- called organic aggregates, which are flocculent detrital material thought to originate through some physioco-chemical process of aggregation from dissolved organic materials. The research now proposed is concerned with such aspects of the metabolism of ultraplankton as diurnal cycles of respiration, respective roles of bacteria and flagellates, energy requirement of the entire water column, descriptive aspects of the organic-aggregate community, and further development of methods appropriate to the research. Some of the developmental and exploratory parts may be done in fresh water and inshore marine environments.

SUPPORTED BY U.S. National Science Foundation

5.0967, METABOLISM OF COMPLETE WATER COLUMNS

W.J. WIEBE, Univ. of Georgia, Graduate School, *Athens, Georgia* 30602

The University of Georgia proposes to make estimates of total metabolism of both photosynthesis and respiration for a series of water columns in the Southern Ocean between Antarctica and approximately 50 degrees S latitude. In this investigation, metabolism of all populations from bacteria in the sediments to whales will be considered. Metabolism rates for respiration, photosynthesis and assimilation will be made under in situ conditions of light, temperature, salinity and pressure. The incorporation of pressure represents a new approach. Data on the metabolic rates and flow of energy within the water columns are essential to the analyis of the integrated biological system (ecosystem).

For data on photosynthesis it is proposed to use El Sayed's data as well as a C14 method. Respiration of marine mammals and birds will be taken from available data on abundance and metabolism. Quantitative sampling of bathypelagic and benthic fishes can be estimated from the work of Wohlschlag. Crustacea estimates will utilize work by McWhinney. Ultraplankton estimates will involve a method developed by Pomerey.

The investigation is proposed for Eltanin cruise 37. It requires six stations: (1) shallow water off the Antarctic continent, (2) Antarctic continental shelf, (3) Antarctic continental slope, (4) deep (5,000 m) station in the Southern Ocean, (5) Antarctic Convergence, (6) Divergence. Stations will require at least 48 hours; the cruise party will consist of seven persons.

SUPPORTED BY U.S. National Science Foundation

5.0968, IMPROVEMENT AND APPLICATION OF BENTHIC ALGAL ISOTOPE PRODUCTIVITY MEASURING METHODS

M. DOTY, Univ. of Hawaii, Graduate School, *Honolulu, Hawaii* 96822 (AT(04-3)235-4)

Benthic algal genera and community productivity methods, measurement and interpretation are being studied in seeking an understanding of the changes in algal populations as they vary with longitude in the Central and Western Pacific. The principal algal genera are those conspicuous in the communities where coralline algae, Caulerpa and Eucheuma are abundant. Studies of physio-ecological phenomena such as response of algae to dissolved organic material, current and their periodicities are specific approaches.

SUPPORTED BY U.S. Atomic Energy Commission

5.0969, SENSORY PROCESSES, MARINE AND HUMAN

G. VONBEKESY, Univ. of Hawaii, Laboratory of Sensory Sciences, *Honolulu, Hawaii* 96822

The investigators propose to conduct research on the sense organs and transmission pathways of man and other animals, particularly the marine animals. Different sense modalities will be studied and compared for common general sensory principles as well as for principles specific to particular senses.

Initial investigations will study the amplifying mechanism in sensory tranducers, the role of inhibition in localization and sensory magnitude, inhibition between point sources in the eye, nerve membrane permeability, the role of free radicals in the nerve impulse conduction and sensory changes with neurological disease. A variety of experimental techniques will be employed, such as electrophysiological recording, electron spin resonance, psychophysical average error matching, and psychophysical location.

SUPPORTED BY U.S. National Science Foundation

5.0970, REGULATION OF IONIC CONSTITUTENTS OF PROTOPLASM

H.B. STEINBACH, Univ. of Chicago, Graduate School, *Chicago, Illinois* 60637

The work in general, consists of a series of studies to determine how living cells manage their inorganic ion content.

More specifically, the projects include: A. Studies on regulation of water and salts by frog skins. Empty sacs of skin can manufacture a fluid, nearly isotonic to normal blood and of concentration and composition nearly independent of the external bathing media. This system is being studied as a convenient device for solving problems of secretion. B. Studies on the relationship of K ion to amino acid contents of marine invertebrate muscle and nerve. As an example, crab nerve and crab muscle have about the same intracellular concentration of amino acids but nerve extract contains a high proportion of dicarboxylic acids and double the K concentration as compared to muscle. C. Comparative studies on fresh water invertebrates and their ability to manage osmotic problems. D. Intracellular distribution of ions, studied by re-distribution of muscle fiber components during high speed centrifugation in isopycnotic media.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0971, STRUCTURE AND REACTIVITY OF PROTEINS AND LIPOPROTEINS

F.R. GURD, Indiana University, Graduate School, *Bloomington, Indiana* 47405

The proposed work will continue the comparison of structure reactivity relations among myoglobins of different species. Much of this work is directed at relating the crystalline structures of these proteins, which are either known or under study, to their chemical reactivity characteristics, and in turn observing the chemical reactivity in solution. The conformations of fragments of the myoglobins prepared by specific cleavage reactions will be studied. Similar work will be begun on human hemoglobin. A summary of many of the aims of this work can be found in the Journal of Biological Chemistry, 243, 683 (1968).

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0972, DEVELOPMENT OF POLARITY IN THE FUCACEAN ZYGOTE

L.F. JAFFE, Purdue University, Graduate School, *Lafayette - West Lafayette, Indiana* 47907

The mechanism of localization or pattern formation is a central problem of developmental biology. A large electrical current begins to flow through the developing Fucus egg as its polarity becomes irreversibly determined. The current intensifies as the egg becomes grossly differentiated into rhizoidal and thallus cells, and this current is likely to be the cause as well as an effect of this localization process. The current may affect localization in either or both of 2 ways: It generates a cytoplasmic field sufficient to concentrate some large negatively charged particles at the basal pole and also involves enough ions to directly produce large gradients of ions across the embryo.

The method of measuring the current is being refined to allow a probing of the field around, and an influence of the currents entering, single developing eggs. Then, using this single cell method, it is proposed to more closely measure the transcellular currents during the rhizoid localization process in the Fucus egg, and then to survey such currents in a wide variety of other eggs during localization processes.

SUPPORTED BY U.S. National Science Foundation

5.0973, RENIN AND EURYHALINITY

H. SOKABE, Toho University, *Tokyo, Japan*

The physiological role of the renin-angiotensin systems as an aldosterone stimulating factor has been elucidated. The studies have been mostly performed in dogs or humans. Information in other animals, especially in the lower vertebrates are relatively scarce.

The first purpose of this project is to determine chemically and histochemically the presence of renin in the kidney of the lower vertebrates from Aves to Agnata, and to study the ultrastructure of the site of renin secretion, that is the juxtaglomerular apparatus in Mammalia.

The second purpose is to investigate the role of the renin angiotensin system in the lower vertebrates. We have found that the system plays a role in the osmoregulation of fishes.

The work will furnish not only phylogenic information on the renin-angiotensin system, but suggestions to solve the problems in the mechanism of control of renin secretion in Mammalia.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0974, ULTRASTRUCTURE OF CELL ION TRANSPORT MECHANISMS

D.E. COPELAND, Tulane University of Louisiana, Graduate School, *New Orleans, Louisiana* 70118

Electron microscope observations are continued on the cellular fine structure of tissues specialized to the transport of salts. Comparative studies have been made on the anal papillae of mosquito larvae (which can absorb salts from water that is almost pure) and the gills of the brine shrimp (which can secrete salt while the animal is living in pure brine, i.e. crystalizing salt concentrations). Both show in common a unique plasma membrane/mitochondrial membrane association which I have labeled 'mitochondrial pump.' A similar 'pump' is found in the Blue Crab gill and is responsible for absorbing salts when the animal is adopted from sea water doron to fresh water. An unusual method of pinocytosis is seen in the basal folds of the cells, involving outpocketings of the folds. This may be the mechanism for the first step in Diamonds' theory of salt and water movement.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0975, THE BIOLOGY AND CHEMISTRY OF TRACE ELEMENTS IN MARINE AND ESTUARINE WATERS

W.R. TAYLOR, Johns Hopkins University, Graduate School, *Annapolis, Maryland* (AT(30-1)-3497)

The objective of the project is to clarify the biogeochemical cycles of trace elements through the initial trophic levels of the Chesapeake Bay. Both biological and chemical samples have been collected in the major river entering the upper Chesapeake Bay and a series of stations in the Bay. Chemical analyses are done by atomic absorption spectrophotometry. Both phytoplankton and zooplankton organisms are being surveyed quantitatively for spatial and time distribution patterns.

The chemical sampling program is nearly complete. Analyses for iron, manganese, copper, nickel, zinc and cobalt have been partially completed. The trace metal requirements of representative phytoplankton organisms are being investigated. An iron requirement has been found for five algae. Cladocerans appear to be a major component of the zooplankton.

SUPPORTED BY U.S. Atomic Energy Commission

5.0976, PHYSICAL AND BIOLOGICAL OCEANOGRAPHY OF A LUMINOUS BAY

W.D. MCELROY, Johns Hopkins University, Graduate School, *Baltimore, Maryland* 21218 (AT(30-1)-3480)

The present study will be concerned with a detailed physical and biological study of one well protected bioluminescent bay in Jamaica. However, the equipment constructed for this study will be used for additional studies at other sites such as the luminescent bay on the south shore of Puerto Rico and our own Chesapeake Bay in Maryland. There are several biological parameters that will be studied but two that are very useful and can be measured quantitatively are photosynthesis and luminescence of the phytoplankton.

The Jamaican 'Phosphorescent Bay' is ideal for our proposed studies and is located near the town of Falmouth on the north shore about twenty miles east of Montego Bay. The density of the organisms in this bay is most unusual and forms essentially a constant bloom. The average depth of the bay is about four feet with a surface area of about one square kilometer. The bay is bordered on the north, east and south by dense strands of mangrove trees. The entire Falmouth Harbor lies behind extensive offshore coral reefs and the bay is therefore protected from extreme wave action. The tidal variations are very small - seldom more than 12 cm. Thus this is a well protected bay that supports heavy growth of dinoflagellates - an ideal place for study since it is not, as yet, affected by tourists in contrast to other such bays. From our previous investigations we feel that the bay is an ideal natural oceanographic model possessing many characteristics of larger estuaries. Continuous monitoring of temperature, salinity, tide, climate, fresh water influence, flushing rates, etc. will produce a series of records that are essential for the interpretation of the biological data. As an oceanographic model the waters of the bay may, at some future date, be manipulated physically and/or chemically to study the relative effects of such change upon both oceanographic and biological aspects.

SUPPORTED BY U.S. Atomic Energy Commission

5.0977, IMMUNOLOGY AND SEROLOGY OF MARINE ANIMALS

G.E. KRANTZ, U.S. Dept. of Interior, Biological Laboratory, *Oxford, Maryland*

Serological and biochemical techniques are employed to describe differences among genera, species, and subpopulations of marine animals (fishes, mollusks, Crustacea). Preliminary studies of the cellular and humoral responses of invertebrates to injected foreign proteins and particulate antigens have been initiated. Clinical diagnostic tests and comparative serology of parasites of marine animals are being developed to enhance analysis of variation in healthy and diseased marine animals.

Serological techniques include the development of rabbit antisera for use in immuno-electrophoresis, agglutination, precipitin, complement fixation, and fluorescent antibody tests. Biochemical studies utilize agar, starch, and polyacrylamide gels, and cellulose acetate in electrophoretic studies of proteins and enzymes from invertebrate tissues (body fluids, serum, hemocytes, muscles, and style).

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0978, TISSUE CULTURE - VIROLOGY

A. ROSENFIELD, U.S. Dept. of Interior, Biological Laboratory, *Oxford, Maryland*

Attempts are being made to establish in vitro monolayer cell cultures of marine invertebrate tissues (particulary Crassostrea virginica) for the purpose of using cultured cells to study the life cycles and physiology of certain infectious agents (such as certain viruses, bacteria, fungi, and protozoans) as well as to study the cytopathogenic manifestations, biochemistry, morphology, and cytology of the cultured cells themselves.

Tissue explants and dispersed cells taken from a variety of oyster tissues are planted in commercial and laboratory prepared media with and without supplements under a variety of environmental conditions. Addition to media of mitotic initiators such as colchicine and phytohemagglutinin are also being attempted.

Maintenance for periods up to three weeks of isolated oyster cells and up to 10 months for heart tissues has been accomplished. However, cell division and concomitant increases in cell number have not been observed, nor have cell lines as yet been established.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0979, IONIC PERMEABILITIES OF THE SQUID GIANT AXON. - EFFECTS OF CHEMICAL AGENTS

L. BINSTOCK, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Washington - Bethesda, Maryland* 20014

The ionic current flow across the membrane of the squid giant axon and the central nerve cord of a marine worm has been measured, without the complications of excitation and propagation, after a sudden change of the membrane potential. The currents have been analyzed in terms of the membrane permeability to sodium and potassium ions. Much of classical nerve physiology is explained by these permeabilities which are themselves not understood. The long range objectives are the further interpretation of nerve function in terms of these fast ionic permeabilities and the elucidation of the structures and mechanisms by which the permeabilities are controlled. The original instrumentation of the potential control concept has been extensively modified and expanded in continuing work with the squid axon. The membrane potential is measured between micropipette internal and nearby external reversible electrodes and is maintained and changed as required by an electronic control system. This system computes, produces, and measures the necessary flow of membrane current between axial and external axon electrodes to follow commanded rapid changes of the membrane potential. Considerable progress has been made in improving the reliability, speed and simplicity of the system.

The voltage clamp technique allows measurements of ionic current flow across nerve membrane as a function of voltage and time. These parameters have been combined into a set of empirical equations capable of expressing nerve membrane activity, but the physical meaning of the equations is unknown. It is hoped that the use of various chemicals known to effect nervous activity may contribute to understanding the physical mechanisms of the membrane. Irrespective of the chemical properties of the substances, this may permit dissection of the lumped parameters of the equations as well as a correlation of known chemical properties with the observed effects.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0980, FORMATION AND METABOLISM OF NEUROHUMORAL TRANSMITTER SUBSTANCES IN MARINE ANIMALS

E.A. BROWN, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Washington - Bethesda, Maryland* 20014

Studies of the metabolism of appropriate compounds in more primitive animals can offer clues to the evolutionary development of those enzyme systems which break down both foreign compounds and naturally occurring substances in the body. Levels of the classically studied drug metabolizing enzymes have therefore been determined in several tissues of pelagic animals. The observation that shark interrenal body contained surprisingly high levels of an endogenous substrate for transmethylating enzymes led to the discovery that conversion of norepinephrine to epinephrine takes place in this organ. The elasmobranch interrenal body is analogous to the cortex of the mammalian adrenal gland. The presence of what is usually a medullary function in such a tissue suggests that this organ can be utilized to study the interrelationship between corticosteroids and catcholamines.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0981, METABOLISM OF NEUROHUMORAL TRANSMITTER SUBSTANCES IN MARINE ANIMALS

E.G. TRAMS, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Washington - Bethesda, Maryland* 20014

This study represents an attempt to follow development of neurohumor transmitter substances and their metabolism in animals lower on the evolutionary scale.

Pelagic organisms have developed not only varients of transmitter substances (such as octopamine) but also a variety of potent blocking agents (neurotoxins) and it is hoped that a better understanding of their structure and metabolism may aid in elucidating the function of neurohumoral transmitters.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0982, MORPHOLOGIC REGULATORY MECHANISMS IN TERRESTRIAL AND MARINE ORGANISMS

J. GROSS, Mass. General Hospital, *Boston, Massachusetts* 02114

The mechanisms of formation, organization and removal of structural elements of animal tissues during development are under investigation. To understand the way these processes are regulated and synchronized with each other, work has been directed to the fibrous protein, collagen, since this structural element is involved in practically all tissue remodeling processes from embryogenesis through senescence.

Five areas are under investigation: (1) morphogenesis of collagen in reaggregating sponges and the germination of gemmules, (2) collagen biosynthesis in reaggregating sponges, (3) hormonal regulation of protein synthesis and comparative studies in fish and amphibia, (4) formation and properties of yolk protein in teleosts, and (5) autonomy, regeneration and collagenases in invertebrates.

SUPPORTED BY U.S. National Science Foundation

5.0983, MOLECULAR MECHANISMS IN BIOLOGICAL CLOCKS

J.W. HASTINGS, Harvard University, Graduate School, *Cambridge, Massachusetts* 02138

Studied in the area of biological rhytimicity - endogenous persistent rhythms, which continue to occur even when the organism is kept under constant conditions - are being carried out. A unicellular photosynthetic organism, the marine dinoflagellate Gonyaulas is being used. It exhibits several rhythms (photosynthesis, luminescence, cell division) and has been shown to exhibit rhythmicity in the isolated single cell.

This research is concerned explicitly with the molecular nature of the rhythmic mechanism and how it controls the 'target' systems.

SUPPORTED BY U.S. National Science Foundation

5.0984, MOLECULAR STUDIES OF DIFFERENTIATING CELLS

E. BELL, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139

Although a number of reports have concluded that the mature, unfertilized sea-urchin egg is quiescent, recently experiments have made it clear that this view is not longer tenable. It is true nonetheless that fertilization results in an increase in the rate of protein synthesis. The less active, or previously thought 'inactive' state, of the unfertilized egg has been attributed to defects of one kind or another in the egg's protein synthesizing apparatus. Much recent work has focused on 'masked' m-RNA.

The research is concerned with regulation of macromolecular synthesis in mature clam and sea urchin eggs before and after fertilization, in developing and differentiating pollen grain cells and in cells of the chick lens and feather which pass through distinct phases of proliferation, morphological differentiation and senescence.

SUPPORTED BY U.S. National Science Foundation

5.0985, MOLECULAR ASPECTS OF CELLULAR DIFFERENTIATION AND DIVISION

P.R. GROSS, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139

Work primarily on early stages in the embryogenesis of the sea urchin is underway, making use of concepts and methods developed in molecular biology, in relation to the transcription of genetic information and its translation into new proteins.

Identification underway on the intracellular location and ultrastructural features of stored mRNA, the fraction of the genome represented by stored messengers, and such architectural details of the stored particles as may influence their utilization in protein synthesis. Further evidence will be obtained on the translation-level control of protein synthesis during early development of the sea urchin, with respect to the whole pattern of protein biosynthesis and to the assembly of certain differentiated organelles, including microtubules, cilia, mitotic proteins, and membrane derivatives. Certain features of the metabolism of early embryos, related to cell division and differentiation without growth, will be studied. Among them is the initial absence of ribosomal RNA synthesis accompanied by a rapid increase in the number of chromosomes.

SUPPORTED BY U.S. National Science Foundation

5.0986, FILAMENTS, MORPHOGENESIS AND CONTRACTION OF MUSCLE

B. KAMINER, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

The main objectives of the proposed study are to gain a better understanding of the molecular structure of muscle filaments and of the factors which influence their pattern of organization, size and stability. Comparative studies of myosin filamentogenesis, for example, suggest that the intrinsic structure of the myosin molecule determines the size of the natural filaments under given environmental conditions.

The in vitro findings will be applied to living muscle and also to problems in muscular dystrophy.

SUPPORTED BY Marine Biological Laboratory

5.0987, CELL DIVISION, BIOENERGETICS, CHEMISTRY OF MUSCLE

A. SZENTGYORGYI, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

Our research has made it probable that cells are kept in the quiescent state by glyoxal derivatives which are present. Though these are contained in animal cells in surprisingly high concentration, they were not discovered until the present because they are masked. It is the object of the proposed research to collect more data about their distribution and function, prepare them in pure condition, establish their chemical configuration and synthetize them. It is also our object to draw closer, the relation of these glyoxal derivatives to incidence and the development of cancer, and to establish the optimal conditions for their possible therapeutic use.

SUPPORTED BY Marine Biological Laboratory

5.0988, PRODUCT/PROCESSING DEVELOPMENT RESEARCH

J.A. EMERSON, U.S. Dept. of Interior, Technological Laboratory, *Ann Arbor, Michigan*

Four discrete phases of activity are being pursued: (1) Increased mechanization of industrial processing, (2) Development of new products from problem fish species, (3) Investigation and evaluation of new preservation techniques, and (4) Extension to members of industry current and forthcoming information to assist in the resolution of industry's problems.

The mechanization phase provides for surveys of various types of processing equipment currently available, and determining the interest and capability of manufacturers in developing and producing suitable equipment not now available, and conducting in-plant tests of such forthcoming equipment.

Product development is primarily concerned with the utilization of problem species such as carp, sheepshead, and small chub towards the production of fillets, blocks, and boneless, skinless raw material for portion-controlled, frozen, reconstituted products.

The evaluation of new preservation techniques is presently concerned with a detailed study of the application of controlled atmospheres to the extension of refrigerated shelf life of freshwater fishery products. This study is being conducted in cooperation with Whirlpool Corporation, who provides atmosphere generation equipment at this laboratory and technical assistance. This method of preservation will be evaluated as to its application to both vessel and shore installations from the standpoints of effect on product quality and comparative economics to simple refrigeration and other preservation methods. In addition, studies will be conducted in conjunction with the laboratory's irradiation project, as to the effects of controlled atmospheres as a pre- or post-irradiation treatment.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0989, UTILIZATION OF FRESHWATER FISH FOR ANIMAL FOODS

R.A. GNAEDINGER, U.S. Dept. of Interior, Technological Laboratory, *Ann Arbor, Michigan*

Detailed studies on the time/temperature relationships for inactivating enzyme thiaminase were completed. The purpose of the study was to examined the potential usefulness and energy requirements for related heat processing approaches for rendering whole, thiaminase- containing fish safe for animal foods, particularly mink.

Subsequently, an experimental fish reduction process, under study for making fish press-cake from thiaminase-containing fish, was modified to convert the approach to a continuous pressure cooker type. The initial bench-scale model was scaled up to a pilot plant or working model and is presently undergoing testing. In addition to developing engineering and economic-related specifications for production-size models, press-cake and meals will be prepared for extensive 2-year mink feeding studies that are planned for initiation this year under a separate project.

Studies are underway or are planned to examine several experimental FPC products made from whole fresh fish, press cake, and fish meal, utilizing several freshwater industrial species. Solvent extraction procedures will be employed; resulting products will be examined for yield and general composition data, their content of elemental residues, and biological response by feeding studies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0990, NUTRIENT ASSIMILATION RATES - FIELD STUDIES

W. ABBOTT, Gulf Coast Research Laboratory, *Ocean Springs, Mississippi*

A series of estuarine ponds have been formed by capturing a bayou channel between levees. The ponds are utilized for factorial experimentation on effects of various nutrients in multiple dose combinations.

Phosphorus studies have shown that the ultimate fate of an added tracer spike is conditioned by the recent fertilization history of the pond. Ability of the whole pond ecosystem to function as a sort of 'phosphorus buffer' is indicated by the results.

Repetition of phosphorus studies and studies on the nitrogen cycle are planned for the near future.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0991, STUDIES ON INORGANIC NUTRIENT ASSIMILATION RATES IN ESTUARINE PONDS

W. ABBOTT, Gulf Coast Research Laboratory, *Ocean Springs, Mississippi*

The captioned research grant has provided funds for construction of 18 estuarine ponds. These ponds are being utilized for field scale testing of hypotheses developed during a series of microcosm studies (Abbott, J. Water Poll. Control Fed., 38:258-270 (1966); 39: 113-122 (1967).

Studies are oriented toward evaluation of phosphorus and nitrogen turnover rates, kinetics of uptake of these elements, and validity of their roles as limiting nutrients in hyperfertilized estuarine situations.

SUPPORTED BY Rockefeller Foundation

5.0992, MECHANICAL PROPERTIES OF MAMMALIAN CELLS

R.W. CORELL, Univ. of New Hampshire, School of Engineering, *Durham, New Hampshire* 03824

Cells are the basic building elements of living organisms. The gross or macroscopic mechanical behavior of tissues is dependent upon the rheologic properties of the cells themselves. Research in this field, in recent years, indicates that considerable effort will be required at the cellular level before more complete understanding is obtained for the gross rheologic properties of groups of cells or tissues. Therefore, a student-faculty team is studying the viscoelastic properties of individual cells. To accomplish this, stationary cultured cells are grown in the laboratory. Diluted suspensions containing the cells whose rheological characteristics are sought, are studied by injecting living cells into a nutrient filled microscope chamber. The cells are viewed through a horizontally mounted research microscope. The cells, in time, settle down through the nutrient solution. Some of the cells settle on an optical viewing platform. The data on the flow and deformation characteristics of the cells on this platform are obtained by time-lapse photomicrographs. These photomicrographs provide the experimental data from which a number of characteristics are determined as a function of time, including: 1. Cell Shape. 2. Rate of Change of Membrane Stress. 3. Strain in Cell Membrane.

SUPPORTED BY University of New Hampshire

5.0993, STUDIES ON THE STRUCTURE OF HEMERYTHRIN

G.L. KLIPPENSTEIN, Univ. of New Hampshire, School of Agriculture, *Durham, New Hampshire* 03824

Hemerythrin, the oxygen-carrying protein of certain marine invertebrates, including the sipunculoids, is being studied from a structural point of view. There are three general aspects to this project: 1) A study of the primary structure of the hemerythrin of the sipunculoid Golfingia gouldii and analysis of the structures of several molecular variants of hemerythrin which occur in this species. 2) An examination of the primary structure of the hemerythrin from another sipunculoid species, Dendrostomum pyroides, and evaluation of similarities and differences between this and G. gouldii hemerythrin. 3) An investigation into the structure of the active or iron-binding site in hemerythrin. This latter project involves chemical modification studies on the protein of G. gouldii and studies comparing the structures of hemerythrins of several species.

The goals of this research are: 1) to gain insight into structure- function relationships in this protein system, particularly with regard to the structure and chemistry of the iron-protein linkages; 2) to provide information on the evolution of this protein and the evolutionary relationships between invertebrates containing hemerythrin.

SUPPORTED BY University of New Hampshire

5.0994, BIOCHEMISTRY OF DEVELOPMENT

M. SPIEGEL, Dartmouth College, Graduate School, *Hanover, New Hampshire* 03755

Brief Description of Research Project: Isolated blastomeres of the sea urchin embryo, if taken at early cleavage stages, are able to regulate almost perfectly to form a normal larvae of reduced size. Methods have been devised to isolate pure cell suspensions of the three sizes of later blastomeres: micromeres, mesomeres, and macromeres. These cells, when recombined in sea water, are capable of reaggregating to form normal embryos.

Using this technique, investigations are underway, as suggested by previous workers, to determine whether RNA is first synthesized in micromeres and this RNA is then transported to other cell types. If this hypothesis is supported, the investigation of whether this RNA synthesis is correlated with the inductive capacity of micromeres is proposed. Further investigation is also underway on the effects of poly-U on unfertilized and fertilized sea urchin eggs and to continue investigations on the identification of the protein synthesized during early development with particular emphasis on the basic proteins. Other projects underway include (1) an investigation of the 'appearance,' localization and chemical composition of a basic protein found during amphibian gastrulation, and (2) investigations on the factors regulating tryptophan pyrrolase activity in development.

SUPPORTED BY U.S. National Science Foundation

5.0995, PHYSIOLOGICAL AND BIOCHEMICAL REQUIREMENTS OF PHYTOPLANKTON SPECIES

J. MAHONEY, U.S. Dept. of Interior, Sandy Hook Marine Lab. , *Highlands, New Jersey*

Description of Work: Grow pure cultures of each species in various salinities, light intensities, photoperiods, and temperatures to determine their gross physiological tolerances. By varying the composition of chemically defined artificial sea water media, 1) determine nutritional requirements of species 2) determine which of those non-essential nutrients available in the sea the species is capable of utilizing. Determine carbon, nitrogen and phosphate sources, vitamins, and trace metals utilized by each species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0996, CELL CONTACT IN RELATION TO GROWTH AND MORPHOGENESIS

M. STEINBERG, Princeton University, Graduate School, *Princeton, New Jersey* 08540

A research program to study cellular properties of adhesion, aggregation, sorting out and migration is underway. Fundamentally, it is hoped to explain how the arrangement of diverse types of cells into tissues is brought about; how this arrangement is maintained; and how it is re-established following disturbance to it. The proposed studies will contribute to our knowledge of 1) the associations and spatial arrangements adopted by cells and tissues in mutual contact; 2) the degrees of selectivity exercised by cells in adopting these associations; and 3) the origins and magnitudes of the physical forces under the influences of which cells and tissues rearrange themselves.

One area of investigation, the selectivity of cell adhesion will employ an examination of chick embryonic cells to determine whether adhesions between cells of different histotypes are initiated randomly or discriminately, and of whether homologous cells 1) of fore and hindlimb and 2) of mouse and chick make adhesive distinctions between one another. Sponge cell aggregation will be studied in a similar manner by use of the electron microscopy together with specific stains which reveal cell surface

constituents as a means for quantifying cell aggregation and the affects of agents upon it; and the use of microscopic electrophoresis as a means for determining certain physical chemical properties of the sponge cell surfaces.

SUPPORTED BY U.S. National Science Foundation

5.0997, ECOLOGY OF SKELETAL PLANKTON

***A.W. BE*, Columbia University, Graduate School, *New York, New York* 10027**

Grant NSF GB-155 assisted in the investigation of living plankton Foraminifera. Dr. Be now wishes to extend his studies to include two other calcareous shell bearing groups of plankton, Pteropoda and Coccolithophoridae. Regional planktonic surveys in the Pacific, Atlantic and Indian Ocean are to be continued in order to obtain data on the geographic, bathymetric, and seasonal distributions of plankton populations. Collected material is to be sorted, identified and enumerated. All data will be processed and subjected to multivariate statistical analysis using computers. The knowledge of spatial and time distributions of contemporary species belonging to these three groups should lead to a coherent analysis of their environmental significance. This in turn is a prerequisite for extending the degree of accuracy and reliability of interpreting fossil assemblages and paleoenvironments in deep sea sediments.

SUPPORTED BY U.S. National Science Foundation

5.0998, GRANT FOR RESEARCH IN ISOLATION OF MARINE PROTEINS

***O. ROELS*, Columbia University, Graduate School, *New York, New York* 10027**

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY John J. Ryan & Sons Incorporated

5.0999, INTERACTION OF PROTEINS WITH METAL AND HYDROGEN IONS

E.M. BRESLOW*, Cornell University, School of Medicine, *New York, New York

Studies of cupric and zinc ion - binding to ribonuclease will be continued to elucidate the mechanism by which ribonclease is inhibited by these ions. Particular emphasis will be given to the application of gel-filtration chromatography to determine binding constants and to study of the interactions of nucleotides and metal ions upon binding to ribonuclease.

Studies of the protein neurophysin will continue with the aim of developing new purification procedures and of characterizing in greater detail the interactions of neurophysin with oxytocin and vasopressin.

Myoglobin investigations will emphasize further studies of the conformational relationships between myoglobin and apomyoglobin, and the mechanism of protoporphyrin-sensitized apomyoglobin photooxidation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.1000, A HISTOCHEMICAL STUDY OF THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS

***R. VONBURG*, Fordham University, Graduate School, *New York, New York* 10458**

Acetylcholine has been implicated as a transmitter in the neurogenic heart of Limulus (Carlson, 1909). It has also been demonstrated that it enchances the firing rate of the abdominal ganglia (Von Burg, and Corning, 1968), after ectopic application. Histochemical studies are underway that will attempt to localize cholinesterase activity in the central nervous system of adult organisms.

SUPPORTED BY Fordham University

5.1001, NUTRITIONAL STUDIES ON MARINE ORGANISMS

L. PROVASOLI*, Haskins Laboratories Inc., *New York, New York

This grant continues support of a long-range examination of the fundamental nutritional aspects of marine ecology, such as the nutritional relationships between the organisms and the chemical environment, and the relationships between organisms. The results of these studies have revolutionized our thinking on the trophic relationships of phytoplankton.

The project will now be extended into three new phases which, nevertheless, represent a continuation and development of this program. Each is an attempt to apply microbiological thought and methods to outstanding problems in marine ecology. The specific goals are concerned with neglected ecological and practical problems. The role of light in the production of nutrients other than carbohydrates is to be investigated.

The second phase will involve the examination of metabolites as morphogenetic factors for seaweeds in order to obtain information which will lead to successful cultivation of these marine plants. Finally, the nutrition of marine crustaceans is to receive attention.

The search for methods to create micron-sized particles as nutritious as the microorganism comprising the normal food of the filter feeders will be continued. Since phagotrophy is common in invertebrates, such a technical advance would be widely useful in the laboratory culture of marine invertebrates.

SUPPORTED BY U.S. National Science Foundation

5.1002, EXPERIMENTAL MANIPULATION OF MECHANICAL AND PHYSIOLOGICAL RHYTHMS - A DUAL APPROACH TO THE BIOLOGICAL CLOCK PROBLEM

***J.D. PALMER*, New York University, Graduate School, *New York, New York* 10003**

The circadian activity rhythms of several species of passerine birds and the tidal activity rhythm of the fiddler crab (Uca) will be studied under a variety of photo- and thermoperiods, under constant conditions, and under thermal stress in an attempt to discover new properties of these rhythms. Secondly, the photosynthetic rhythm of the very large, single-celled algae, Acetabularia, will be studied (polarographically) in a variety of experimental conditions. These cells can be easily enucleated so that the various roles of the nucleus and the cytoplasm in biological rhythms can be ascertained.

SUPPORTED BY U.S. National Science Foundation

5.1003, CHEMISTRY AND FUNCTION OF BRAIN PLASMALOGENS

***M.M. RAPPORT*, Yeshiva University, School of Medicine, *New York, New York* 10033**

The chemistry and biochemistry of plasmalogens are under study. The organic chemistry of alpha, beta-unsaturated ethers is being examined in relation to possible functions of this type of lipid in mammalian and marine animal tissues. Enzymic as well as chemical characterizations of the phosphatidal species (plasmalogens) serve to distinguish them from the structurally analogous phosphatidyl species (diacyl phosphatides), and further studies of the difference are in progress.

Phosphatidal ethanolamine appears to be a major constituent of the myelin membrane that may have metabolic as well as structural significance. The biochemical relevance of a number of systems is being investigated.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.1004, CHANGES IN THE LIMITING NUTRIENT DUE TO TEMPORAL, GEOGRAPHIC, AND DEPTH VARIATIONS

***G.S. POSNER*, City University of New York, Graduate School, *New York - City College, New York* 10031**

Laboratory and field studies of nutrient enrichment are being used to explore the effect of geography, depth in the water column, time and factors associated with time of a non-cyclical nature on nutritional factors controlling phytoplankton abundance in New York and semi-tropical waters.

SUPPORTED BY City University of New York

5. LIVING SYSTEMS (NON-HUMAN)

5.1005, BIOLOGICAL PRODUCTIVITY IN THE SARGASSO SEA, THE GULF STREAM AND IN THE ATLANTIC COASTAL WATERS OFF CAPE HATTERAS

P.R. BURKHOLDER, Columbia University, Graduate School, *Palisades, New York* 10964

Studies will be conducted to determine seasonal variations in the biological productivity in the U.S. Atlantic Coastal Waters, the Gulf Stream, and the continental slope and shelf between Montauk Point and the Chesapeake Bay. The influence of effluents entering the ocean via the Hudson River and Chesapeake Bay estuaries, on the plankton in the shelf area and in adjacent water masses will be determined. Consideration will be given to possible radionuclide accumulation in plankton and other indicator organisms. Integrated biological studies will include measurements of primary productivity and of the standing corp of plankton and nekton and their chemical composition. Supporting data will be obtained for inorganic and organic nutrients in the water and for light energy available for photosynthesis in the water columns at all stations. By using different types of collecting apparatus and suitable screens for sorting various particle sizes of organisms in the food chain, an attempt will be made to evaluate the biomass of different size classes of organisms which contribute to the total biomass. These materials will also serve for the biochemical study of protein metabolism at different trophic levels in the sea, with particular reference to the sequences leading from phytoplankton to crustaceans to important species of fish. The data will be compared to that obtained during 1966-1967 in the coastal area off Cape Hatteras, Gulf Stream and Sargasso Sea.

Six cruises were accomplished to date: (5 aboard R/V EASTWARD) E- 2-66: Jan. 10-14, 1966. E-27-66: July 11-15, 1966. E-36-66: Sept. 12-16, 1966; E- 4-67: Jan. 16-20, 1967. E-24-67: May 22-27, 1967. 1 cruise: July 31, - Aug. 12, 1967. A full data report on cruises E-2- 66 & E-36-66 has been completed and is available to AEC. A data report on the other three cruises is in preparation.

SUPPORTED BY U.S. Atomic Energy Commission

5.1006, VITAMIN A AND PROTEIN METABOLISM

O.A. ROELS, Columbia University, Graduate School, *Palisades, New York* 10964

It is the purpose of the present investigation to determine the metabolic function of vitamin A outside the visual cycle. Vitamin A is essential for growth and growth is specifically related to protein synthesis. Previous studies in our laboratory have indicated a close relationship between peptide synthesis and vitamin A status. Intracellular free amino acid concentrations appear to be governed by the vitamin A status of the animal. The size of the intracellular amino acid pools may be governed by protein anabolism or catabolism or by the transport mechanisms of amino acids or peptides across the cell membrane. Effect of retinol and its derivatives, of alpha tocopherol and of the coenzyme Q group of compounds on the structure and function of biological membranes is therefore under intensive investigation. Various model systems are being utilized in this study: - lipid monolayers - lipid bilayers - cells and subcellular organelles of mammalian tissue (rat erythrocytes, rat liver) - cells and subcellular organelles of a protozoan (Ochromonas malhamensis)

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.1007, EFFECT OF LIPIDS ON STABILITY OF BIOLOGICAL MEMBRANES

O.A. ROELS, Columbia University, Graduate School, *Palisades, New York* 10964

It is the purpose of the present study to determine the effect of retinol, alpha-tocopherol, coenzyme Q and their analogs and metabolites on the stability, the structure and the function of biological membranes.

Lysosomes, microsomes and plasma membranes will be isolated by density gradient centrifugation and will be used for further studies concerning the effect of certain lipids on membrane stability and function. The relative purity of the centrifuged fractions and the fine structure of the particles and membranes will be investigated by electron microscopy in conjunction with biochemical studies of the same preparations. These combined biochemical and electron microscopic studies should clarify the influence of certain lipid factors on the structure and function of biological membranes.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.1008, MECHANISMS OF CYTOKINESIS IN ANIMAL CELLS

R. RAPPAPORT, Union College & University, Graduate School, *Schenectady, New York* 12308

Division of animal cells is a physical event which can best be analyzed by physical experimentation. Despite early recognition of the importance of cytokinesis in the lives of cells and organisms, available information has been fragmentary and derived from study of a very few forms. In this investigation experimentation will be extended to cell-types not usually used and new experiments will be devised. Several areas of investigation will be pursued. A better understanding of the events which determine where division will take place will help in analysis of the nature of the division process as well as revealing more about the preparatory phase. Once division has begun, it will be possible to subject the source of the required force to biophysical analysis and thus learn more of its constitution.

As circumstances permit, three different cell types will be used for experiments - vertebrate cells in tissue culture, dividing marine invertebrate eggs and dividing amphibian eggs. Investigations will be carried out at the Union College campus and the Mount Desert Island Biological Laboratory.

SUPPORTED BY U.S. National Science Foundation

5.1009, ZOOPHYSIOLOGY OF OCEANIC BENTHIC ANIMALS OFF THE NORTH CAROLINA COAST

F.J. VERNBERG, Duke University, Graduate School, *Beaufort, North Carolina* 28516

There has been considerable speculation about the factors which influence the zoogeography and speciation of oceanic animals. However, there is limited documentation with observational and experimental data. The oceanic waters off the North Carolina coast are not only rich in fauna as shown by recent ecological studies but also offer markedly different biogeographic regions. In the present study it is proposed to try to characterize the physiological parameters which are operative in two of these biogeographic areas. One of these areas in a submerged reef in the warm waters of the Florida current, the other a cold-water area just north of Cape Hatteras and Diamond Shoals. These physiological studies would include both resistance and capacity adaptations of various stages in the life cycle of the dominant species of both areas. The physiological indications of adaptive responses to the environment to be studied would include reproductive cycles, feeding behavior as influenced by temperature, measurement of various overt function responses and metabolic-temperature curves using animals acclimated to different thermal levels, and osmoregulatory ability at different temperatures.

SUPPORTED BY U.S. National Science Foundation

5.1010, PRODUCTIVITY OF ESTUARINE AND MARINE ECOSYSTEMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)

R.B. WILLIAMS, U.S. Dept. of Interior, Radiobiological Lab., *Beaufort, North Carolina* 28516

All life ultimately depends on autotrophic organisms. Therefore, knowledge of primary production in estuaries is required for evaluation of their potential to produce commercially important fish and shellfish, and for elucidation of the movement of radionuclides through estuarine food chains into edible species. The primary production of phytoplankton and benthic algae, two groups of autotrophs important in the characteristically shallow southeastern estuaries, is being measured at regular intervals in inshore waters near Beaufort, N. C. Phytoplankton production is estimated by the light and dark bottle technique. Bottles of seawater (with zooplankton removed by filtration) are incubated for 24 hours at several fractions of surface illumination, and changes in dissolved oxygen are determined by titration. To estimate benthic production, areas of bottom are enclosed (in situ) for 24 hours beneath clear and opaque plastic bell jars, and changes in dissolved oxygen within the jars are obtained by titration of water samples withdrawn from them. In addition, measurements of standing crop accompany the measurements of production.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.1011, MACROMOLECULAR EVENTS OF FERTILIZATION AND EARLY EMBRYONIC DEVELOPMENT

D.W. STAFFORD, Univ. of North Carolina, Graduate School, *Chapel Hill, North Carolina* 27514

The aggregation of the sea urchin, Arbacia punctulata, ribosomes gives rise to a question: Are sea urchin egg ribosomes fundamentally different from those of E. coli or rat liver, or is their aggregation caused by 'sticky' proteins in certain cells? This problem is being approached by adding isolated E. coli ribosomes to ribosome-free supernatant prepared from the sea urchin. The ribosomes are pelleted by centrifugation, and the degree of aggregation determined. If this experiment results in aggregation, this system will be tested for activation of protein synthesis by proteolytic enzymes.

In addition, the isolation of a ribonuclease inhibitor from sea urchin eggs and the methods for handling sea urchin ribosomes are being worked out. A previous project on sea urchin sperm mid-piece DNA is being completed, and studies on in vitro protein synthesis in bull sperm mid-piece are being continued.

SUPPORTED BY U.S. National Science Foundation

5.1012, MACROMOLECULAR BASIS FOR ADAPTATION TO SALINITY CHANGES IN PRYMNESIUM PARVUM

G.M. PADILLA, Duke University, School of Medicine, *Durham, North Carolina* 27706

Decreasing salinities to 5% sea water reduces the growth rate of Prymnesium parvum as well as the rate of synthesis of RNA and protein. Yet the content of both of these components rises on a per cell basis. Acute shifts in salinity induce a five-fold increase in RNA content within six hours after the shift. Both of these observations suggest that P. parvum adapts to lower salinities through the synthesis of new macromolecular components involved in permeability functions. Increasing salinities induce a faster growth rate and reduce content of RNA and protein. The DNA content remains constant. Toxin synthesis on the other hand achieves its maximum levels at 75% sea water.

Biosynthetic pathways by which macromolecules are synthesized following salinity shifts and the relevance of such synthesis to permeability functions are being examined. These experiments are being coupled to the analytical separation of subcellular structures by density zonal ultracentrifugation and examination with the electron microscope in order to determine the cytological sites of adaptation to salinity changes and toxin synthesis.

SUPPORTED BY U.S. National Science Foundation

5.1013, NATURAL COMPOUNDS WITH CARBON-PHOSPHORUS BONDS

L.D. QUIN, Duke University, Graduate School, *Durham, North Carolina* 27706

The insoluble protein remaining from extractions performed on marine animals is being examined for the presence of compounds with C-P bonds. Coelenterates in general seem to be positive in this sense; a number of other animals are negative, but some contain C-P compounds in extractable form. The nature of the bonding of 2 aminoethylphosphonic acid (AEPA) in the protein is being studied by subjecting the material to degradations. Small fragments amenable to structure determination have been obtained; one fragment appears to contain AEPA and aminosugar, and is being investigated further. One sea anemone has been encountered in which the predominant C-P compound in the protein residue is 2-(methylamino) ethylphosphonic acid, and the project will include studies on the mode of bonding of this substance.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.1014, SUBCELLULAR REACTION TO INJURY IN THE KIDNEY

B.F. TRUMP, Duke University, School of Medicine, *Durham, North Carolina* 27706

The principal research objective is the delineation, at the subcellular, supramolecular, and molecular levels, of the response of kidney cells to lethal as well as sub-lethal injury. The principal emphasis is on the structural and functional modulation of cellular membranes as they relate to modification of energy transduction by these systems. Complementary objectives include an understanding of the ultrastructural characteristics of human renal disease, methods of ultrastructural and cytochemical analysis, and the ultrastructural basis of active transport. Particular attention has been given to the study of systems such as isolated, perfused flounder tubules and toad bladders in Ussing chambers, where correlations between alterations of structure and function can be made.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.1015, MECHANISMS OF CALCIUM CARBONATE DEPOSITION

K.M. WILBUR, Duke University, Graduate School, *Durham, North Carolina* 27706 (NONR)

The investigator will continue his analysis of physiological and biochemical and crystallographic mechanisms of calcium carbonate deposition in shells and other structures in marine organisms. In particular, during this renewal period, the principal investigator will concentrate on the ultrastructure of the barnacle shell and its relations with the substratum. The calcium deposition process will be studied, in part, radiographically after exposure of the animals to Ca45 in sea water.

One of the aims of the research in this programmatic area of interest is the discovery of vulnerable stages in the life cycles of fouling organisms. Physical or chemical intercession at these stages could provide the means for the prevention of attachment to submerged structures and equipment. Data resulting from this research will help prepare Navy planners for combating fouling, and will furnish information that can be used to reduce the yearly multimillion dollar cost, maintenance, delay, etc., caused by this fouling.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.1016, CALCIFICATION MECHANISMS IN MARINE ORGANISMS

K.M. WILBUR, Duke University, Graduate School, *Durham, North Carolina* 27706

The general objective of our program is a comparative study of calcification systems in certain marine organisms. It has two major phases. The first is a study of the ultrastructure of each system with particular attention to the relationship of crystal formation to cell components and the organic matrix. The second phase concerns physiological aspects of calcification with emphasis on conditions which favor and inhibit calcification.

The studies are being carried out on the following: 1. Amino acid analysis of organic matrix in mollusc shells 2. Analysis of extrapallial fluid of molluscs 3. Intracellular localization and transport of calcium by marine algae 4. Experimental studies of nucleation and crystal growth in the organic matrix of marine algae.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.1017, PRODUCTIVITY STUDIES IN NORTH CAROLINA SALT MARSHES

A.W. COOPER, Univ. of North Carolina, School of Agriculture, *Raleigh, North Carolina* 27600

This research will study primary productivity in North Carolina salt marshes. Studies in other areas have shown that salt marshes are among our most productive natural communities. Salt marshes fix large quantities of solar energy and perhaps as much as half is washed out by the tide into estuarine waters and forms a major source of food used by commercial and sport fin- and shellfish which inhabit estuaries during some point in their life cycle. Despite their obvious importance, salt marshes are subject to great destructive pressures by man. There have been no studies of productivity in North Carolina and such studies are needed to enable the State to develop better policies with respect to its management of these lands and associated waters.

Initial field work will obtain data needed for a final classification of community types in North Carolina salt marshes. The distribution of these types will then be mapped from aerial photographs and the total acreage of each type determined. Detailed studies will then be made of primary productivity within each type. Clip-samples will be used first, but it is hoped that these will be supplemented by refined data using techniques such as gas analysis so that estimates can be made not only of net productivity but also of gross productivity. From these data and the distribution data estimates of total productivity of each type on the entire coast will be made.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
North Carolina State University

5.1018, CONDUCTION AND INTEGRATION

R.K. JOSEPHSON, Case Western Reserve Univ. , Graduate School, *Cleveland, Ohio* 44106

Work in this laboratory is directed toward an understanding of physiological mechanisms controlling behavior in lower animals. Specific projects planned include (1) a comparative study of pacemaker systems and conducting systems in hydrozoan polyps, (2) a study of the properties of electrically active epithelia in Hydra, and (3) and investigation of the neural control of sound production and of rapidly contracting muscles used in singing by the katydid Neoconocephalus robustus.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.1019, PRODUCTIVITY OF OCEANIC POPULATIONS OF VERTICALLY MIGRATING ANIMALS

W.G. PEARCY, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Project Description: Collections obtained with meter plankton nets and midwater trawls will provide data on the number and biomass of common species of vertically migrating animals off Oregon. Changes in size frequency distributions of species will be used to estimate growth rates. With periodic estimates of growth and population size, net production will be calculated. Seasonal and inshore-offshore variations in numbers and population size structures will also be studied, particularly in regions influenced by upwelling.

SUPPORTED BY U.S. National Science Foundation

5.1020, ENERGY TRANSFER IN LOWER MARINE TROPHIC LEVELS

L.F. SMALL, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

We are obtaining estimates of energy flow in significant second trophic level grazing organisms in the pelagic marine environment. Currently we are employing respiration and growth measurements, and ingestion-egestion measurements, and propose to compute carbon budgets. Effects of temperature, light, pressure, food types and concentrations, and grazer concentrations are being investigated. Extrapolations of physiological data in the laboratory to conditions in the sea are to be attempted, to assess relative importance of various organisms in the energetics of the pelagic biota.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.1021, POPULATION STUDIES ON INTERTIDAL INVERTEBRATES

P.W. FRANK, Univ. of Oregon, Graduate School, *Eugene, Oregon* 97403

Using recently developed techniques of marking, the investigator is determining longevity and growth rate of a number of gastropod mollusks, and of several species of echinoderms (Asteroidea). Growth of all sizes is observed for at least a 1-year period. Work is being done at the Great Barrier Reef Committee Research Station at Heron Island, Queensland, Australia, and along the Oregon coast.

The main information to be gained concerns 1) whether longevity on a tropical reef is relatively high--as is to be expected from agruments about stability of the fauna; 2) the extent to which data gathered on size distributions may be of value in making predictions about longevity. Comparisons will be made between different species, and between different populations of the same species. Specific organisms concerned, for the Barrier Reef: Nerita albicilla, Trochus pyramidus, Conomurex luhuanus, Monetaria annulus, Conus flavidus and Conus spp.; Fromia spp. For the Oregon coast: Tegula funebralis, Searlesia dira.

SUPPORTED BY U.S. National Science Foundation

5.1022, COMPARATIVE STUDY OF NITROGEN SECRETION IN FISHES

R.W. MORRIS, Univ. of Oregon, Graduate School, *Eugene, Oregon* 97403

The investigator plans to investigate some aspects of gas secretion in fishes, specifically the possibility of metabolic origin of at least some of the nitrogen found in the gas bladders of certain bony fishes.

Comparative studies will be run on anadromous species, freshwater fishes from freshwater ancestry, marine fishes of recent freshwater ancestry, freshwater fishes of marine ancestry, and marine fishes of marine ancestry. Gas will be removed from the gas bladders of the fishes, fishes will be denied access to molecular nitrogen during regeneration of its contents by brine kept in an atmosphere of commercial oxygen (less than 1.0% N_2). These will be run with suitable controls for varying periods of time.

SUPPORTED BY U.S. National Science Foundation

5.1023, NEUROSECRETION AND ENDOCRINE PHYSIOLOGY

L.H. KLEINHOLZ, Reed College, Graduate School, *Portland, Oregon* 97202

The proposed work continues studies with the physiological and chemical characterization of four neurosecretory hormones of the crustacean eyestalk: the retinal pigment hormone, a family of chromatophorotropins, and the diabetogenic hormone. The basic physiological and bioassay methods have already been established. The major portion of current and future work deals with purification of the separate hormones, determination of their physiological specificities. It is expected that amino acid compositions of these will be determined, and hopefully, that sequence studies will be made on the purified peptide hormones.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.1024, NUCLEIC ACID AND PROTEIN SYNTHESIS DURING OOGENESIS

M.J. ALLEN,

The transcription and translation of genetic information during oogenesis and early development in spiralian eggs, specifically those of the polychaetous annelids (Antolytus and Chactopterus) and those of the gastropod mollusc Ilyannasa, are being studied. This study involves exposure of developing eggs and embryonic stages to the radioactive precursors of nucleic acids and proteins in conjunction with actinomycin D and puromycin. The chief aims (besides continuing the radioautographic studies of Autolytus eggs) are: 1) to extend to annalid eggs biochemical studies similar to those on Ilyanassa and sea urchin eggs, and 2) to detect differential gene activity in spiralian eggs (specifically those of the gestropod Ilyanassa) by radioautography; in effect, to make a biochemical cell lineage study on thhese eggs.

SUPPORTED BY U.S. National Science Foundation

5.1025, PRIMARY PRODUCTIVITY IN PUERTO GALERA BAY, MINDORO, PHILIPPINES

A.A. DELACRUZ, Univ. of The Philippines, *Manila, Philippines*

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

5.1026, CHEMICAL RESPONSES BY MARINE ORGANISMS TO STRESS

H.P. JEFFRIES, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

The ocean is physically stable compared with land and freshwater environments, and the medium has intimate association with the life it bathes. Consequently marine organisms have developed less complex regulatory systems than their terrestrial and aquatic counterparts. But when the ocean does change -- by natural processes or as the result of pollution -- it follows that the biotic community will also change, along with the ecosystem's ability to process waste materials. Homeostatic control at the community level is, therefore, an essential element in understanding the sea's populations, especially in coastal waters where environmental oscillations are large.

The major goal of this investigation is to identify and measure quantitatively the ways marine communities respond to ecological stress. The internal responses are measured in terms of homeostasis; the external stresses result from temperature, salinity, competition, food and pollution.

The first phase of this investigation showed that the balances of free amino acids, fatty acids and blood constituents are sensitive indicators of environmental conditions. Relationships observed in nature between external stress and internal composition are now being analyzed in the laboratory. In addition, the genetic determinants of chemical specificity will be separated from environmental influences in copepods, mollusks and fishes.

When we know the minimum stress intensities and corresponding maximum internal tolerances within which normal community composition and function are maintained, we should be able to predict the fate of populations living under various conditions of water quality.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.1027, TROPHIC RELATIONSHIPS IN SHOAL BENTHIC ENVIRONMENTS

N. MARSHALL, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

Shoal benthic environments in the estuaries of the southern New England coast are very productive in the natural state. Trophic relationships in these habitats are being pieced together through studies of producer and consumer groups. Since little is known of the organic matter contribution by the benthic microflora special attention is being directed to this group, assaying production from 14C uptake by intact and undisturbed sediment samples. Attention is also directed to improving techniques for this assay.

SUPPORTED BY U.S. National Science Foundation

5.1028, AGE DETERMINATION OF LARGE ATLANTIC SHARKS

J.G. CASEY, U.S. Dept. of Interior, Marine Game Fish Research Lab., *Narragansett, Rhode Island* 02882

Sample sharks from southern New England to North Carolina. Collect vertebrae that represent full ranges of sizes, section vertebrae to treat for microscopic examination; interpret year marks using standard techniques of age determination; prepare growth curves for Carcharhinus milberti, C. obscurus, Carcharias taurus, Carcharadon carcharius, Prianace glauca, and Sphyraena zygaena.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.1029, LIPASE RESISTANT GLYCERIDES

N.R. BOTTINO, Texas A & M University System, School of Agriculture, *College Station, Texas* 77843

The long-chain highly unsaturated fatty acids typical of aquatic animal lipids, (eicosapentaenoic, docosapentaenoic, and docosahexaenoic acids) are known to be located preferentially in the 2-position of the glycerides of marine crustacea and fish. On the other hand, these acids are located in the extreme positions of whale oil triglycerides. The reasons and mechanism for the change in position are being investigated by feeding whale oil, fish oil, and shrimp to pigs. It is expected that the pig, whose triglycerides, like those of the whale, possess higher unsaturation in the extreme than in the middle positions, will distribute the long-chain highly unsaturated fatty acids in a manner similar to that of the whale. As a control, groups of rats which have the 'normal' predominance of unsaturation in the middle position of their triglycerides will also be fed whale oil and fish oil, separately.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.1030, BIOLOGICAL PRODUCTIVITY INVESTIGATIONS OF THE WATERS SURROUNDING ANTARCTICA

S.Z. ELSAYED, Texas A & M University System, Graduate School, *College Station, Texas* 77843

This amendment to Texas A&M Research Foundation proposes participation in the Weddell Sea Expedition during austral 1967-68 to investigate the biological productivity of the Weddell Sea with emphasis on factors governing organic production for comparison with other Antarctic regions. The objectives are: (1) to estimate standing crop of phytoplankton in euphotic zone; (2) to measure primary productivity by C14 uptake method (3) measure light transmission and solar radiation; (4) study concentration of nutrient elements; (5) study condcentration of soluble and particulate organic carbon; (6) and obtain plankton samples. This participation represents an extension of shipboard work on USNS Eltanin in South Pacific under GA-915 and will utilize existing supplies and equipment essential for the additional work, with the personnel accommodation provided by this amendment.

Equipment and supplies for the work aboard USCGC Glacier will be provided by USARP. The principal investigator will be assisted on shipboard by two assistants from Texas A&M Research Foundation and one technician from the USCGC Glacier.

SUPPORTED BY U.S. National Science Foundation

5.1031, LIPID COMPOSITION OF ANTARCTIC MARINE ORGANISMS AND SEA WATER

L.M. JEFFREY, Texas A & M University System, Graduate School, *College Station, Texas* 77843

The objectives of the research are to utilize the low temperature flora and fauna populations of the Antarctic Ocean to determine: A. The effect of temperature on the lipid composition of phytoplankton, zooplankton and fish. B. The influence of temperature on polyunsaturated fatty acid metabolism of marine organisms. C. The changes in the triglyceride and phospholipid (Polar lipid) structure and fatty acid composition of marine oils as they pass through the entire food chain, including whales. D. The relation of kinds and amounts of marine water lipids with plankton production in Antarctic and Gulf of Mexico waters.

SUPPORTED BY U.S. National Science Foundation

5.1032, ORGANIC PRODUCTION OF EPIFAUNAL ORGANISMS

W.E. PEQUEGNAT, Texas A & M University System, Graduate School, *College Station, Texas* 77843

Research will be continued on the energy budget of the biomass of rock-reefs of the sublittoral zone. Growth rates of the living population will be studied, primary production of the area will be determined, the concentrations of soluble and particular organic carbon in the ambient water will be measured; from these and supplemental data, on local currents and associated hydrographic information, calculations will be made with regard to the amount of energy required to support an incomplete ecosystem of this kind.

Possibilities in control of, protection against, and utilization of biological material and activity are also considered in this program. Information resulting from this research will be particularly useful in the prediction of the type and distribution of organisms which cause or affect fouling and deterioration of submerged equipment and structure.

SUPPORTED BY U.S. Dept. of Defense - Navy

5. LIVING SYSTEMS (NON-HUMAN)

5.1033, CARBON DIOXIDE FIXATION IN HETEROTROPHIC ORGANISMS III THE BREAKDOWN OF GLYCOGEN IN MARINE INVERTEBRATES

J. AWAPARA, Rice University, Graduate School, *Houston, Texas* 77001

Our previous work has established that a large number of marine invertebrates degrade glycogen to yield products not commonly observed in other animals. Of these products, succinic acid appears in abundance. In order to account for the formation of one molecule of succinic acid from one molecule of glucose carbon; three of the six glucose carbons flow into succinic acid, a process which requires two reductive steps. The two reductions are balanced by the oxidation of two molecules of glyceraldehyde phosphate during glycolysis. The other three carbons undergo reactions to produce alanine. None of the reactions involve oxidoreductions.

All the above expectations have been realized and proven by a series of experiments. The ratio of alanine to succinic acid formed from glucose was found to be one in every instance.

In sum: many marine invertebrates degrade glucose as follows: (Step 1) Glucose reacts to form 2 phosphoenolpyruvic acid (PEP). (Step 2) PEP reacts to form pyruvic acid, which reacts (Step 3) to form alanine (Step 4) PEP reacts to form oxalacetic acid which reacts (Step 5) to form malic acid which, in turn, reacts (Step 6) to form fumaric acid, forming (Step 7) succinic acid. Two molecules of coenzyme are reduced in (1); the two molecules of reduced coenzyme serve as the reducing agent in steps (5) and (7). Although the pathway of glucose breakdown has been elucidated in general terms, there remain some difficult questions to be answered. For example, how is fumaric acid reduced to succinic acid when oxygen is present. Under those conditions it is unlikely that the reduction is the reverse reaction of the oxidation of succinic acid by the mitochondrial succinic dehydrogenase.

We are now studying the reduction of fumaric acid in marine organisms in the presence of oxygen.

SUPPORTED BY Robert A. Welch Foundation

5.1034, PRESENCE OF ENZYMES RELATED TO DNA SYNTHESIS IN EGGS OF ECHINODERMS

R.E. BLACK, Coll. of William & Mary, Graduate School, *Williamsburg, Virginia* 23185

BRIEF DESCRIPTION OF RESEARCH PROJECT: Research on protein synthesis during sea urchin development is underway to determine which enzymes related to DNA synthesis are present in the cytoplasm of eggs and which enzymes must be synthesized. The enzymes concerned in the experiments are the deoxynucleotide kinases and DNA polymerase.

The enzymes will be studied in preparations of nucleate and enucleate egg fragments prepared by centrifugation of the unfertilized eggs of various species. The presence of the kinases and polymerases in enucleate and nucleate halves will be evaluated under exposure to puromycin to determine whether the enzymes are stored in the nucleus or cytoplasm or both, are found in sperm nuclei, and/or are synthesized during each cleavage division.

SUPPORTED BY U.S. National Science Foundation

5.1035, BIOCHEMISTRY OF FISH MUSCLE AND QUALITY CHANGES

H.S. GRONINGER, U.S. Dept. of Interior, Technology Laboratory, *Seattle, Washington*

Many of the biochemical reactions that occur in post-mortem fish muscle affect the flavor and textural quality of the muscle. Some of the enzyme catalyzed degradations of nucleotides and nucleosides appear to be important quality changes.

The objectives of this work are (1) to study some of the nucleotide and nucleoside degradations in fish muscle, and (2) to study potential methods of controlling these reactions.

Results: The dephosphorylation rate of inosinic acid (IMP) was found to vary over a fairly wide range in the muscle from different species of fish. There was some difference in the heat stability of the enzymes from different species. It was found that the dephosphorylation of IMP could be inhibited in certain species by treatment of the muscle with ethylenediamine tetraacetic acid. In substrate specificity studies it was shown that the dephosphorylation activity can be attributed mainly to the nucleotidase enzyme. The nucleotidase activity is found mainly in the microsomal fraction after centrifugation of muscle extracts.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.1036, MEASUREMENTS OF OXYGEN CONSUMPTION BY THE SEA BED IN DEEP WATER OF PUGET SOUND

K. BANSE, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

Instrumentation to push light and dark bell-jars into the sediment under TV control will be used to measure the in situ oxygen consumption of the level sea bed in Puget Sound to 200 m depth. Oxygen electrodes and telemetry will be employed. Eight stations on which the infauna is well known will be visited quarterly for one year. The oxygen consumption in cores will be studied at the same time. The fraction, due to the macrofauna of the total oxygen consumption of the bottom will be estimated. In shallow water, oxygen production from microscopic benthic algae will also be measured.

SUPPORTED BY U.S. National Science Foundation

5.1037, CYTOPLASMIC FILAMENTS AND CELL MOVEMENT IN DEVELOPMENT

R.A. CLONEY, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

Brief Description of Research Project: The development of any metazoan is characterized by a complex series of cellular movements leading to increased cellular interaction, functional specialization and structural complexity. A theory of development depends, in part, on an understanding of cellular kinetic mechanisms and their regulation and control in ontogeny.

Ultrastructural studies revealed oriented filaments and microtubules in cytoplasm fixed in a phase of movement. Experiments are performed with ascidians (tunicates) where contraction of the caudal epidermis during metamorphosis is accompanied by extensive and rapid alignment of filaments in the axis of shortening. The epidermis contracts to 1/20 of rest length in only six minutes. Data obtained from time lapse cinematography, electron microscopy and a variety of experimental methods support the hypothesis that the filaments are contractile elements.

Work is continuing to determine to what extent the contractile mechanism in the caudal epidermal cells of the ascidian is related to contractile mechanisms in other cells (such as muscle and fibroblasts) in terms of structural and physiological properties. The development of birefringence in the caudal epidermis of living specimens with the reorganization of filaments observed in ultrastructural studies of fixed tissues will be correlated.

SUPPORTED BY U.S. National Science Foundation

5.1038, BIOLOGICAL OCEANOGRAPHY

T.S. ENGLISH, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The broad objective is to determine the daily and seasonal distribution of phytoplankton, zooplankton and organic detritus in a typical water column beneath the ice and to measure the annual biological productivity. Kinds of organisms, their size, absolute abundance, life history stages and movements are studied in relation to physical factors of the environment. Special emphasis is placed upon quantity of light at various depths and to the transfer of radiant to chemical energy by phytoplankton populations whose abundance is measured by analysis of the concentration of chlorophyll a. Productivity is studied by carbon-14 techniques and energy transfer is followed through the food chain from producers through the several trophic levels of consumer populations.

Distribution, kinds, numbers and behavior of planktonic organisms and detritus contribute to knowledge of the total environment of Arctic.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.1039, THE EFFECTS OF SEAL AND FISH PREDATION ON CERTAIN ANTARCTIC BENTHIC COMMUNITIES

R.T. PAINE, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The additional funds for GA-1187 will permit complementary work on the research of trophic stratification within shallow water communities. This will consist of (1) collection of sediment samples with a piston corer adjacent to the established experimental, exclusion cages and (2) quantitative enumeration of bacteria present. A second addition to the original proposal is measuring the respiratory (maintenance) cost of the dominant benthos to permit ecologically more dynamic standing crop measures for information on decomposers active in the Antarctic marine communities. This will be conducted by the principal investigator. For the purposes of the additional field objectives and to provide necessary assistance in the planned scuba work, two more graduate assistants are included under the supplement.

The field work will be conducted at McMurdo Station, principally during the austral summer by four scuba graduate assistants. The principal investigator will be at the Bio Lab one month. Plans for early winter participation are under consideration.

SUPPORTED BY U.S. National Science Foundation

5.1040, STUDIES ON GAMETOGENESIS IN HYDROMEDUSAE

E.C. ROOSENRUNGE, Univ. of Washington, School of Medicine, *Seattle, Washington* 98122

A detailed and, as far as possible, a quantitative exploration of the sequence of events in the regeneration of gonads after castration is to be carried out in Phialidium by means of observations on the living, histology, and electron microscopy. The source and mode of proliferation of germ cells is to be investigated by labelling with thymidine-H3. External factors which stimulate or inhibit regeneration of ovaries or testes are to be explored. Steroid hormones are of most immediate interest. In addition, the role of the gastrodermis and the influence of gonadal tissues on gonadal regeneration will be studied.

SUPPORTED BY U.S. National Science Foundation

6. PUBLIC HEALTH AND SAFETY

6A. FOOD AND FOOD SANITATION

(fish Protein Concentrate; Seafood Processing and Marketing; Irradiation.)

6.0001, BOTTOM FISH, FISH WASTE, SCRAP FISH & OTHER SEA PRODUCTS FOR FUR ANIMAL DIETS

J.R. LEEKLEY, Univ. of Alaska, Agricultural Experiment Sta., *College, Alaska* 99735

Object: To determine the relative feeding value to fur bearing animals of ocean and fresh water fish, fish products now being discarded by canneries and cold storage plants, sea mammals that are harmful to commercial fisheries in Alaska, scrap fish available in the Great Lakes region, and other products which have no market for human consumption.

Plan of work: Feeding tests at Petersburg will be made on various types of fish, fish waste products and sea mammals singly and in combination. Special consideration will be given to compounding satisfactory feed mixtures and to nutritional characteristics of diets made of maximum of readily available Alaska feed ingredients. Chemical analyses will be run as necessary. Rates of growth and complete breeding and reproduction records will be kept on animals receiving test diets. Various vitamins, antibiotics, antioxidants, and other supplements and preservatives will be tested as to desirability and level of feeding, with emphasis on further comparison of the relative value of phenolic antioxidants and to tocopherols in control of yellow fat disease, and on the value of certain dietary iron compounds in prevention of cotton pelts. Work at Ithaca will be continued on the use of trawler chubs and alewifes (Great Lakes fish species) in diets for mink.

SUPPORTED BY U.S. Dept. of Agriculture

6.0002, PROCESSING ALASKA SHRIMP

J. COLLINS, U.S. Dept. of Interior, Technological Laboratory, *Ketchikan, Alaska*

This research involves a general study of the processing of pink shrimp. Specifically, we plan to modify existing methods or develop new ones to improve quality and develop new products.

Immediate improvements in quality can be made by developing an alternate method to the ice-holding method currently used to prepare shrimp for mechanical peeling. A pre-cooking technique that is being developed as an alternate to ice-holding results in much better quality and suggests end products other than canned. Accordingly, methods are being studied to produce a machine-peeled frozen cocktail style pack to replace the scarce and costly hand-peeled product.

Since the red color of the shrimp is an important factor of quality, current studies are concerned with the stability of the carotenoid pigments during peeling and other operations in the canning process. Conditions of retorting (time and temperature) are being studied. The use of the various additives to stabilize the carotenoids during frozen storage of machine-peeled, blanched, frozen shrimp are being studied.

The program is a continuing one and future projected work will include vessel unit handling and delivering systems, and demonstrations of the need for developing heading and sorting equipment.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0003, PROCESSING KING CRAB

R.D. TENNEY, U.S. Dept. of Interior, Technological Laboratory, *Ketchikan, Alaska*

This project is designed to improve quality and increase value of king crab seafood products by improving canning methods by increasing natural moisture retention, by adopting new freezing methods, and by combing raw freezing with satisfactory thawing and shucking variables. Additionally, to fabricate by-products of king crab waste to provide a useful product from large amounts of costly material which is presently discarded to form a pollution problem.

Work is being done on the use of polyphosphates as additives for control of moisture retention and reduction of canning defects such as sulfide blackening and struvite. This approach is now nearing completion.

There is a need for freezing methods that are more efficient and more amenable to use aboard vessels and ashore. Studies on brine freezing of cooked crab have been initiated and will be followed by storage studies with chemical and organoleptic testing of brine frozen product over a time temperature cycle.

In combination with the brine-freezing studies on cooked crab, studies on both brine-freezing and blast-freezing of raw crab will be made. Experimentation of thawing, cooking and extraction of meats through manipulation of these variables will follow to determine an efficient method of processing raw frozen crab.

Additional studies on protein quality of meal processed from crab waste are in progress in conjunction with other laboratories. These studies include mink and chick-feeding experiments using crab meal as a source of protein.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0004, CONSUMER EVALUATION OF FISH PRODUCTS

W.R. MORRISON, Univ. of Arkansas, Agricultural Experiment Sta., *Fayetteville, Arkansas* 72701

The objectives are (1) to investigate the influence of socio economic characteristics of the population on consumer evaluation of smoked buffalo fish ribs, breaded scored fillets; and other products prepared from farm produced fish, (2) to evaluate consumer conceptual image of the products, reaction to product characteristics such as appearance, flavor, aroma, texture, etc., and reasons for these reactions, (3) to estimate market potentials and competitive position of these products.

Description of work - The first phase of the study will be conducted in Memphis, Tenn., with Census Tracts comprising the sampling unit. City blocks will be randomly selected from the census tracts with the number of blocks selected in each tract being dependent upon the population characteristics within the tract. Households will be randomly selected within city blocks. For cooperating households an enumerator will fill out a family questionnaire and will give the homemaker the test item along with special instructions and an evaluation schedule on which the adult members of the household will list their separate evaluations of the test product.

If acceptance of the test items by consumers appears likely, further market testing may be desirable. Experimental procedure for this phase of the study would depend upon the kind of economic information needed. Appropriate analytical techniques for studying consumer acceptance would be used in any further testing.

SUPPORTED BY U.S. Dept. of Agriculture
Arkansas State Government

6.0005, PROGRAM PROJECT - FOOD MICROBIOLOGY

G.F. STEWART, Univ. of California, School of Agriculture, *Davis, California* 95616

Research on food-borne infections and intoxications, especially those caused by the Salmonella and Clostridia.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0006, THERMAL DESTRUCTION OF TYPE E CLOSTRIDIUM BOTULINUM

C.W. BOHRER, Natl. Canners Association, *Washington, District of Columbia*

The characterization and definition of the heat resistance of Clostridium botulinum type E in foods forms the foundation of this project. The interlocking effects of spore production medium, recovery medium for heat injured cells, and heating substrate on resulting resistance found in the initial years of this grant will be expanded. The effects of water activity on outgrowth of spores will be studied both as to optimum growth and limits for outgrowth. In addition, the heat inactivation of the type E toxin will be defined. Knowledge on all of these factors are of extreme importance to food processors, food handlers, and public health officials for use in preventing outbreaks of type E botulism.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0007, DIMETHYLNITROSAMINE IN CURED, SMOKED WHITE FISH AND FLOUR BLEACHED WITH OXIDES OF NITROGEN

C.J. BARNES, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of Food Chem. , *Washington, District of Columbia* 20204

To determine the amount of dimethylnitrosamine in cured, smoked whitefish following treatment with sodium nitrite, and in flour following treatment with oxides of nitrogen.

To determine ethylene dichloride at 5 ppm in whole fish protein concentrate.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0008, RADIOCHEMICAL TECHNIQUES

M.K. ELLIS, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of Food Chem. , *Washington, District of Columbia* 20204

Purpose: To improve, develop, and/or apply radio-chemical techniques for the determination of radionuclides in foods and to promote and/or assist in the utilization of such techniques and Drug Administration research projects and regulatory problems.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0009, TOXIC IMPURITIES IN MARINE PROTEIN CONCENTRATE

T. FAZIO, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of Food Chem. , *Washington, District of Columbia* 20204

To develop qualitative and quantitative methods for the isolation and determination of toxic impurities and their alteration products in marine protein concentrates.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0010, BACTERIOLOGICAL SURVEYS FOR MICROBIAL STANDARDS FOR FOOD

F.A. PHILLIPS, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of Microbiol. , *Washington, District of Columbia* 20204

To compare inspectional and analytical results of good and poor manufacturing operations in order to develop microbiological standards for coliforms, E. coli, coagular-positive Staphylococcus and aerobic plate counts for several classes of food products.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0011, INVESTIGATION OF DECOMPOSITION IN SHRIMP

B.S. RICHARDS, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of Food Chem. , *Washington, District of Columbia* 20204

Purpose: To find a substance or substances indicative of decomposition in shrimp and to devise a method for its determination.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0012, INVESTIGATION OF THE PRESERVATION OF FOODS BY FREEZE DRYING

B.S. RICHARDS, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of Food Chem. , *Washington, District of Columbia* 20204

To determine the effects of freeze drying on sensory, chemical, and physical measurements of decay. Develop chemical indices of decomposition applicable to freeze-dried foods.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0013, CHARACTERISTICS OF CANNED SALMON

G. THOMPSON, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of Food Chem. , *Washington, District of Columbia* 20204

To accumulate information on the characteristics and fill of container of canned salmon involving the five species of Pacific salmon for use in proposing standards for canned salmon.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0014, ELECTROPHORETIC PROFILES FOR THE IDENTIFICATION OF FISH SPECIES

R.R. THOMPSON, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of Food Chem. , *Washington, District of Columbia* 20204

To develop a catalog of electrophoretic protein band patterns for various fish species for use in determining when a cheaper fish species has been substituted for a more expensive one.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0015, COMPOSITION OF BREADED FISH PRODUCTS

J.C. WERREN, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of Food Chem. , *Washington, District of Columbia* 20204

To accumulate information regarding good manufacturing practices on which to base a requirement for fish flesh content and the amount of breading material in proposing standards for breaded fish products.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0016, INVESTIGATION OF FOOD PRESERVATION METHODS

G.E. WOOD, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of Food Chem. , *Washington, District of Columbia* 20204

To develop information regarding the mechanisms of decomposition and preservation processes. Relate organoleptic, chemical, physical, and microbiological data on food spoilage.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0017, INOCULATED PACK STUDIES ON LOW-DOSE IRRADIATED MARINE PRODUCTS - SHRIMP

B.Q. WARD, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

The Contractor will conduct research involving irradiation with ionizing radiation at low-dose on marine products, principally inoculated packs of shrimp. This program will investigate outgrowth and toxin production by the organism Clostridium botulinum, Type E, in the low-dose irradiated shrimp following, as a minimum, the protocol established by an AEC Ad Hoc Committee for this type of study. On completion of the studies on shrimp, the program will proceed with similar studies on oysters.

SUPPORTED BY U.S. Atomic Energy Commission

6.0018, MARKET RESEARCH STUDIES ON THE EFFECTS OF THE FLORIDA MARKETING PROGRAM ON THE SALE OF FLORIDA SEAFOODS

H.W. SHIELDS, State Board of Conservation, *Tallahassee, Florida*

Objective: To determine the degree of effectiveness of the Florida marketing program in increasing the demand for Florida seafoods in retail and institutional markets.

Procedure: The Florida Board of Conservation has contracted with the University of Florida for a study of the effectiveness of the marketing program. The University of Florida has completed the studies and a report will be submitted during 2-11-D-4 period. Funds will be provided the University of Florida to publish this report.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Florida State Government

6.0019, ANALYSIS OF THE DEMAND FOR RED MEAT, POULTRY, EGGS, SEAFOOD, AND MEAT MIXTURES

R. RAUNIKAR, Univ. of Georgia, Agricultural Experiment Sta., *Athens, Georgia* 30602

(1) To estimate levels and patterns of consumption and expenditures for red meat, poulty, eggs, seafood, and meat mixtures by socio-economic groups of the Atlanta urban populaation. (2) To analyze the effect of income, prices, price relationships, race, occupation, education, household composition, and other socio-economic factors on the consumption of various red meats, poultry, eggs, seafood, and meat mixtures, and to determine the substitution relationships among red meats, poulty, eggs, seafood, and meat mixtures, and between these products and their substitutes.

Description of Work: Detailed data on quantity, price, expenditure and form of red meat, poulty, eggs, seafood, and meat mixtures will be analyzed for a panel of approximately 300 households in Atlanta, Georgia. Cross-sectional and time series analyses will be used. The time series analysis will reveal seasonal and cyclical variations in the several food items. Weekly and quarterly summary data will be used to measure the effect on quantity purchased of red meats, poultry, eggs, seafood and meat mixtures resulting from changes over time in prices, income, and price relationships. Substitution relationships will also be analyzed. Work will consist primarily of an analysis of data previously accumulated.

SUPPORTED BY U.S. Dept. of Agriculture
Georgia State Government

6.0020, ESTIMATING THE VALUE ADDED TO SEAFOOD PRODUCTS LANDED IN GEORGIA AT THE VARIOUS STAGES OF THE MARKETING CHANNEL

D.H. CARLEY, State Game & Fish Commission, *Atlanta, Georgia*

Objective: To estimate the value added to seafood products landed in Georgia at the various stages of the marketing channel from the primary producer (fishermen) to the consumer.

Procedure: Prices and/or charges and the amount of each form of seafood product at each stage of the marketing process will be obtained from personal interviews, mail questionnaires, and secondary sources. Quantitative techniques will be used to determine the proportion of the total value of seafood products going to each segment of the industry.

Part 2 of 3.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Georgia State Government

6.0021, ANALYZING THE FACTORS AFFECTING THE DEMAND FOR SEAFOOD AND TO PROJECT THIS DEMAND TO FUTURE TIME PERIODS

C.M. FRISBIE, State Game & Fish Commission, *Atlanta, Georgia*

Objectives: To estimate the effect of physical and socio-economic factors on the consumption of seafoods. To project the demand for sea-food to future time periods.

Procedures: Secondary data from a consumers panel in Atlanta, Georgia, operated from 1958 through 1962 will be utilized to obtain estimates of demand parameters for seafood. A cross sectional analysis will be used to determine the effects of income, race, household, and composition on purchases of seafood.

Pertinent census data on population, population characteristics, and race will be used in combination with derived demand estimates to estimate local and national projected aggregate demands for seafood products.

Location: Experiment, Georgia.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Georgia State Government

6.0022, GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE 34 TO 50 F.

W.P. SEGNER, Continental Can Company Inc., *Chicago, Illinois*

A marked extension of the refrigerated storage life of low dose irradiated fresh marine food products might create a health hazard due to Cl. botulinum Type E, because of its ability to grow at low temperature, the radiation resistance of its spores, and the ubiquity of the organism in marine environments. Studies are in progress to assess the importance of this problem. It is proposed for the contractual year January 15, 1968 through January 14, 1969 that inoculated pack studies be conducted on selected marine products; namely, picked blue crab, clams, and scallops. The protocol recommended by the Ad Hoc Committee to the AEC on botulism will be followed. The relationship between the earliest time for toxin production and the time for unquestionable recognition of spoilage by the potential consumer will be determined.

Inoculated pack experiments were conducted on fresh haddock and cod. The results at 46 F and below are quite encouraging. The results at 50 F are somewhat less favorable than at lower temperatures. However, the 50 F results must be considered in view of the rigorous test criterion used in establishing the maximum product storage life estimates, that being unanimous rejection of a sample based solely on odor as judged by an untrained consumer type panel.

SUPPORTED BY U.S. Atomic Energy Commission

6.0023, ANTIOXIDANT AND NUTRITIONAL POTENTIAL OF FERMENTED AND UNFERMENTED SOYBEANS IN COMBINATION WITH FISH

L.V. PACKETT, Univ. of Kentucky, Agricultural Experiment Sta., *Lexington, Kentucky* 40506

Objectives: To determine the changes in nutrient composition that occur in the fermentation process of making tempeh from soybeans. To preserve whole raw fish by mixing with tempeh and determine the feasibility of this method for preserving fish as a protein source in technologically underdeveloped countries. To evaluate the potential of the antioxidant of tempeh in preventing autoxidation of lipids and deterioration of protein in both raw and freeze-dried whole fish. To determine physiological and tissue effects resulting from consumption of fish, soybeans, tempeh, and fish-soybean and fish-tempeh mixtures as the only protein source in rat and chick diets.

Description of work: Compositional differences in soybeans and fermented soybeans will be determined. High oil and low oil raw dehydrated and freeze-dried fish will be mixed with tempeh or soybeans and stored without refrigeration. Lipid autoxidation organoleptic and protein deterioration test (trimethylamine oxide, trimethylamine, dimethylamine, free tyrosine, volatile fatty acids and decarboxylated amino acids) will be made to assess product quality. Fish and tempeh or soybean combinations will be tested as protein sources. PER and tissue antioxidant capacity (liver homogenate thiobarbituric acid assay, B-glucuronidase activity and tissue respiration) will be determined on rats receiving the fish-soybean and fish-tempeh as a sole source of protein.

SUPPORTED BY U.S. Dept. of Agriculture
University of Kentucky

6.0024, RADIATION PASTEURIZATION OF SHRIMP AND OYSTERS

A.F. NOVAK, Louisiana State University, School of Agriculture, *Baton Rouge, Louisiana* 70803

Radiation pasteurization of shrimp and oysters has proven to be a highly successful procedure for increasing their iced storage life.

Physical, chemical, microbiological, and organoleptic studies have been completed in evidence that this process is safe, and that irradiated shellfish are preferred over the non-irradiated products when subjected to consumer appraisal.

The scope of proposed research will include investigations into the value of reduced temperature during radiation (cryogenics), the required condition of shellfish prior to irradiation, mechanisms by which texture seems to be improved during irradiation, the developments of a simple procedure for determining the extent of radiation, the effect of radiation on traces of insecticidal residues which may be found in shellfish, and the isolation and identification of compounds and their changes during radiation.

Microbiological techniques, chemical analyses, gas chromatography, infra-red spectrum analysis, organoleptic tests and nutritional evaluations will be included in making these studies.

This progress should enable the consumer to purchase a higher quality product, while increasing production and income for the producer.

SUPPORTED BY U.S. Atomic Energy Commission

6.0025, COMMERCIAL IRRADIATION OF SHELLFISH WITH A PORTABLE SHIPBOARD IRRADIATOR

A.F. NOVAK, Louisiana State University, School of Agriculture, *Baton Rouge, Louisiana* 70803

The portable shipboard irradiator will be used for making commercial feasibility studies at a dockside shrimp unloading site on the Gulf coast.

Washed, headed, and iced stored shrimp will be obtained from several trawlers to uncover problems caused by variations in ship construction, and handling by different crews. When arriving dockside, the shrimp will be packaged and irradiated at 0.22 plus or minus 0.05 Megarad, and iced stored for appraising shelf life extension. Products showing evidence of decomposition will not be irradiated.

The samples will be analyzed chemically for indole and ammonia, and microbiologically for total counts and several pathogens. Organoleptic evaluations will include general appearance, odor, texture, sweetness, flavor and blackspot.

Results will be reviewed for possible application to commercial practices, and for solving unforeseen problems which could serve to aid in the preparation of a petition to the F.D.A. for approving low dose radiation preservation of shrimp.

SUPPORTED BY U.S. Atomic Energy Commission

6.0026, CAUSES AND PREVENTION OF UNDESIRABLE CHANGES IN THE QUALITY OF FRESH AND FROZEN GULF SHRIMP IN REFRIGERATED STORAGE

A.F. NOVAK, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803

Cause and prevention of undesirable changes in the quality of fresh and frozen Gulf Shrimp in refrigerated storage. Subproject: Radiation Pasteurization of Shrimp.

Objectives: 1. To extend the refrigerated (32 degrees and 36-40 degrees Fahrenheit) storage life of headless unpeeled shrimp. 2. To extend the refrigerated storage life of peeled deveined shrimp. 3. To extend the refrigerated storage life of cooked peeled deveined shrimp.

Proposed Work: Shrimp samples will be irradiated at 50,000 to 750,000 rads and stored in ice and at 36-40 degrees Fahrenheit. At periodic intervals samples will be removed from storage, unirradiated controls also, for chemical, microbiological and organoleptic evaluation.

SUPPORTED BY Louisiana State Government

6.0027, EVALUATION OF PRESENT AND PREPOSED LAWS REGULATING THE PROCESSING AND PACKING OF OYSTERS

A.F. NOVAK, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803

1. To reappraise the total solids range of Louisiana oysters. 2. To measure the amount of drained liquid obtained with various grades of oysters throughout the year, when processed according to present F.D.A. methods. 3. To study and evaluate improved procedures for processing and packing. 4. To propose regulatory changes to the F.D.A. for the establishment of rational standards favorable to both the packer and consumer.

Proposed Work: Oysters will be processed and packed at several packing houses monthly using present F.D.A. method. Drained liquid content and total solids will be determined after various time intervals of draining after washing.

SUPPORTED BY Louisiana State Government

6.0028, REGIONAL DEMAND IN THE U.S. AND TRENDS IN THE FISHING AND SEAFOOD PROCESSING INDUSTRIES OF THE CHESAPEAKE BAY AREA

R.E. SUTTOR, State Dept. of Ches. Bay Afrs., *Annapolis, Maryland*

Objectives: (1) To determine product classification and regions for demand analysis, determine availability of data, and make preliminary consumption estimates; (2) to determine trends in the Chesapeake Bay catch and resources employed in fishing; (3) to determine trends in the seafood processing industries and their relationship to consumption and the Bay catch.

Procedures: (1) The classification of seafood products which is most relevant to studying regional differences in consumption will be determined. The regions to be used in the demand analysis will be delineated. The available data on the consumption of seafood and the relevant demand theory will be reviewed. Preliminary estimates of regional consumption will be made. (2) Detailed data on the Bay catch will be assembled and analyzed. Labor and capital quantities and wage rates and prices will be used to estimate the value of economic resources employed in the Bay fishing industry. Changes in these resources will be compared with changes in the catch. (3) Trends in the seafood processing industry of the Chesapeake Bay area will be analyzed and the current structural characteristics of the industry will be described. Changes in the industry will be related to changes in consumption and the Bay catch.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Maryland State Government

6.0029, STABILITY OF FOOD LIPIDS TO IONIZING RADIATION

W.W. NAWAR, Univ. of Massachusetts, School of Agriculture, *Amherst, Massachusetts* 01003 (AT(30-1)3499)

The objective of this project is to gain detailed information on the nature and magnitude of radiation effects on the lipids of foods. A combination gas chromatograph-fast scan mass spectrometer system will be used in the continuing identification of the volatile components produced in the lipid fractions of irradiated fish. Various other micro-chemical techniques will be used to determine radiation-induced changes in the nonvolatile fraction. The organoleptic implications of the various compounds characterized as irradiation-induced will be established.

SUPPORTED BY U.S. Atomic Energy Commission

6.0030, EFFECTS OF IONIZING RADIATION ON FOOD LIPIDS

W.W. NAWAR, Univ. of Massachusetts, School of Agriculture, *Amherst, Massachusetts* 01003

Pork fat, beef fat, fish oil and a number of model systems were irradiated under controlled conditions and the volatile components analyzed qualitatively and quantitatively. Dosages from 0.3 to 7.0 megarads were studied. Approximately 50 compounds formed by radiation of fats were identified. The flavor implications of such compounds is being investigated. The effect of the physical state of the fat on the volatiles formed by radiation is under study.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0031, THE EVALUATION OF WHOLESOMENESS OF RADIATION SUB-STERILIZED FOOD PRODUCTS USING RATS

E.F. REBER, Univ. of Massachusetts, Graduate School, *Amherst, Massachusetts* 01003

The phase of the work to evaluate the wholesomeness of irradiation pasteurized clams fed to rats for a two-year period has been completed. The irradiation of clams did not impair the growth, feed efficiency, reproduction of male and female rats. There were indications of significant treatment effects in serum glutamic pyruvic transaminase, lactic acid dehydrogenase and white blood cell counts at various time intervals. There was no significant effect on the sizes of the organs weighed at the time of necropsy which could be correlated with an effect of feeding irradiated clams. Work is planned to investigate the protein quality of clams which appears to be complicated by the presence of thiaminase. Additional work will also be done to investigate the presence and effect of thiaminase as it occurs in clams.

SUPPORTED BY U.S. Atomic Energy Commission

6.0032, CONSUMER EDUCATION AND MARKET DEVELOPMENT

F.C. WILBOUR, State Div. of Marine Fisheries, *Boston, Massachusetts*

Objective: To promote greater utilization of northwest Atlantic seafoods on a national basis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Massachusetts State Government

6.0033, RADIOPASTEURIZATION OF FISHERY PRODUCTS-OPERATION AND DEVELOPMENTAL INVESTIGATIONS

J. HOLSTON, U.S. Dept. of Interior, Technological Laboratory, *Gloucester, Massachusetts*

This contract deals with the investigation of radiopasteurization of fishery products of commercial significance and the establishment of handling and processing methods necessary for commercial application of irradiation in the seafood industry. The work is broken down into two divisions: laboratory research; developmental studies involving the Marine Products Development Irradiator (MPDI).

The major objectives of the research are (1) to establish the maximum edible shelf life of radiopasteurized and nonirradiated haddock and codfish fillets (based solely on odor of raw sample); (2) to determine the optimum dose for radiopasteurizing scallops and blue crab meat; (3) to continue the study of the feasibility of using radiopasteurizing to extend the shelf life of slacked-out products (products stored and handled frozen until they reach the retail outlet whereupon they are thawed and held refrigerated until sold and consumed); (4) to complete the study of the effect of preirradiation quality on post irridation quality and shelf life of clam meats and cod fillets, and to look into the preirradiation quality of ocean perch as it affects the postirradiation shelf life of the fillets; (5) to continue to relate organoleptic changes in radiopasteurized, nonirradiated, and sterile, nonirradiated fish with changes which occur in the composition of the volatile chemical components in the product; and (6) to monitor bacteriological quality of test samples in order to observe relationship between quality of irradiated and nonirradiated fish with total plate counts (e.g., of specific organisms such as Clostridium botulinum, E. coli).

SUPPORTED BY U.S. Atomic Energy Commission

6.0034, RADIATION PRESERVATION OF FISHERY PRODUCTS

J.A. HOLSTON, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Gloucester, Massachusetts*

The objectives of this contract are: Task I. 1. To conduct quality studies on mackeral, whiting, blue crab, scallops, lobsters, and oysters. 2. To conduct applied flavor and odor studies to relate changes in composition of the volatiles of irradiated products to changes in product quality. 3. To expand the studies to determine the effect of pre-irradiaion quality level on post-irradiation shelf life of clam meats, ocean perch, and other species. 4. To ascertain the bacteriological quality of samples initially and periodically following irradiation, and to determine the bactericidal effects of different low dose levels of irradiation. 5. To determine the maximum edible shelf life of fish fillets packed in commercial 20-30 lb fillet tins. 6. To conduct large scale shipping, storage, and distribution tests of marine products in conjunction with the operation of the Marine Product Development Irradiator and in cooperation with the fishing industry. 7. To conduct studies of irradiated and non irradiated commercial size shipments of fresh fish and shellfish with industry to determine efficacy of the radiation treatment. 8. To determine if present commercial distribution and storage conditions are suitable for handling irradiated fresh fillets, and if present market and distribution of these products can be broadened.. 9. To perform irradiation services for AEC-sponsored projects and other approved federal, state, or industry requests. Task II. 10. To operate an on-ship irradiator to establish possible advantages of irradiating seafoods at sea. Task III. 11. Determine the advantage of irradiating in inert or reducing gases. 12. Develop analytical methods to expedite analyses of volatile components in fish in cases where suitable methods do not exist. 13. Determine the absorption characteristics of known bacteriostatic salts in whole fish fillets.

SUPPORTED BY U.S. Atomic Energy Commission

6.0035, LABORATORY SCALE INVESTIGATION INTO THE FEASIBILITY OF RADIOPASTEURIZING FISH PRODUCTS

J.A. HOLSTON, U.S. Dept. of Interior, Technological Laboratory, *Gloucester, Massachusetts*

This research is concerned with many related aspects of determining the feasibility of pasteurizing fish products by radiation. Storage studies are conducted in which we measure the benefits of radiation at 50 to 200 kilorads for fillets and up to 450 kilorads for shellfish by comparing the organoleptic quality, the total plate count, and the shelf life of irradiated samples with those characteristics of the nonirradiated samples. The effects of storage temperature, packaging materials, and initial quality of the fish are determined concurrently. The samples are also studied to determine the composition of their volatile chemical compounds using gas chromatography and mass spectrometry. Significant changes in the concentration of the volatile chemical compounds can thus be related to organoleptic changes, and attempts to control the production of critical compounds can then be made.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0036, IRRADIATION SERVICES AND STUDIES

J.A. HOLSTON, U.S. Dept. of Interior, Technological Laboratory, *Gloucester, Massachusetts*

The Marine Products Development Irradiator operates under contract to the U. S. Atomic Energy Commission for preservation of fresh marine food products. Preservation of foods by ionizing radiation is the newest and least known method of preservation. All foods do not respond in the same manner to identical doses of irradiation. The reasons for this phenomenon can only be determined by performing the necessary experimental irradiation experiments in cooperation with industry and research units. We service all industry requests for experimental irradiation services and all similar requests that arise from university, state or other federal agencies. We supply information and technical services other than irradiation services in joint industry-government studies on specific food irradiation problems. Irradiation services are available at no cost provided such services are not available from private industry.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0037, COMMERCIAL BENEFIT STUDIES

J.A. HOLSTON, U.S. Dept. of Interior, Technological Laboratory, *Gloucester, Massachusetts*

The objective of this study is to determine the magnitude of the shelf life extension conferred by ionizing radiation over non-irradiated control samples of fishery products when both are subjected to the stresses normally encountered by commercial size shipments in regular channels of distribution from fish pier to inland consumer. This research is also aimed at adducing proof that the radiation doses proposed for fresh marine food products accomplish the intended technical effect and do not exceed the amount reasonably required to achieve the purpose of irradiation. The help of qualified industry experts will be solicited to determine the commercial benefits to be derived from radiation treatment of fresh seafoods for extension of shelf life.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0038, INCIDENCE OF BACTERIA OF PUBLIC HEALTH SIGNIFICANCE IN FRESH COMMERCIAL SHELLFISH

J.A. HOLSTON, U.S. Dept. of Interior, Technological Laboratory, *Gloucester, Massachusetts*

Some seafoods such as crabmeat and oysters are commonly eaten with no further cooking. Thus, there exists a greater possibility of transmission of pathogenic organisms by means of these two seafoods than by those shellfish which are always cooked before consumption. The accepted public health indices of bacterial contamination of shellfish (coliforms and fecal coliforms) are labile to pasteurizing dose levels. Therefore, we propose to determine the minimum efficacious radiation dose level of these and other bacteria of public health significance in shellfish. Irradiation treated packs will be subjected to commercial shipping and handling to determine whether or to what extent the usual bacterial indices of sanitation are reduced and held at acceptable levels. Such tests will include total plate counts, coliforms, fecal coliforms, coagulase positive staphylococcus and salmonella.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0039, SHIPBOARD IRRADIATION STUDIES

J.A. HOLSTON, U.S. Dept. of Interior, Technological Laboratory, *Gloucester, Massachusetts*

In work conducted under a Task I project, it was established that the length of the postirradiation shelf life of fish is a function of its preirradiation quality. The main object of this research, scheduled to terminate August 1967, is to determine the extent of the benefit which might be gained by irradiating fish at sea just after catching them. The fresh caught fish are packaged and irradiated at different levels aboard the vessel using a portable irradiator. A storage study of these samples will indicate to us the extent of savings in radiation energy we can expect if we irradiate fish before they undergo bacterial contamination under normal handling. We can also obtain more information regarding the benefits of irradiating fish in the prerigor state which preliminary experiments seemed to indicate, and we can determine the effect of double dose applications (a fractional dose applied at sea followed by a fractional dose applied on land when the vessel docks).

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0040, FUNDAMENTAL RADIATION CHEMISTRY RESEARCH

J.A. HOLSTON, U.S. Dept. of Interior, Technological Laboratory, *Gloucester, Massachusetts*

This project, which is scheduled to terminate September 30, 1967, is concerned with investigating fundamental aspects of Radiation Chemistry. The principle objective is to develop or to modify existing analytical methods. Methodology is required for studying changes in the concentrations of volatile and nonvolatile chemical compounds in fish flesh, and for measuring the penetration of bacteriostatic salts in fish flesh. Practical techniques for conducting applied chemistry research in areas described above have been successfully developed as has a technique for controlling the composition of headspace gases in packaged fish products. The latter technique has enabled us to study the possible synergistic effects of radiation and inert or reducing gases for controlling spoilage in fish.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0041, INVESTIGATION OF FEASIBILITY OF STERILIZING FISH BY RADIATION

L.J. RONSIVALLI, U.S. Dept. of Interior, Technological Laboratory, *Gloucester, Massachusetts*

This research conducted under contract to the U.S. Army Quartermaster is concerned with determining the feasibility of producing shelf stable sterilized fish products. This involves the solution to difficult problems associated with high level radiation (about 4.5 megarads). The problems are to minimize induced radiation effects on flavors and odors to prevent color changes, and inactivate flesh enzymes by some method other than the use of radiation which is considered inadequate for enzyme inactivation. Practical methods which can be used to solve these problems often introduce one or more new problems. Thus, heat, which can be satisfactorily used to inactivate enzymes, unfortunately causes gross, undesirable physical changes in the product.

Under the terms of the contract, research is directed to unprocessed fish products such as fillets, but can be directed towards processed items such as fish cakes, fish rolls, etc. should it be found that it is not feasible to radiosterilize the unprocessed items.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0042, FUNDAMENTAL STUDIES IN THE FLAVOR AND ODOR CHEMISTRY OF FISH PRODUCTS

J.W. SLAVIN, U.S. Dept. of Interior, Technological Laboratory, *Gloucester, Massachusetts* (AT(49-7)2443)

Many published data indicate the feasibility of preserving fish as well as other heat labile food products with ionizing radiation. However, some detrimental organoleptic changes occur as a result of irradiation, extended storage, environmental factors, and combinations of these.

The objective of this research program is to define the development of detrimental organoleptic changes in irradiated fishery products in terms of related chemical and biochemical reactions. The information gained in this research will be used to derive maximum benefit from radiopreservation methods and to otherwise exert control measures to slow, and in some cases prevent, spoilage processes.

The approach employed in this continuing research is to study by instrumental methods, the volatile fractions in fish products since quality is largely reflected by the chemical compounds in their flavors and odors. Techniques to collect volatile compounds have been developed, and recently we modified and combined two analytical methods which enabled us to establish the effect of irradiation, extended storage, available oxygen, temperature, and bacteria on the development of carbonyl compounds in clam meats. We are presently evaluating methods for studying the development of sulfides and mercaptans in spoiling fish, and this will be followed by an investigation of methods to study amines and possibly other compounds. The capability to follow the development of these important compounds is the key to controlling detrimental changes in fish products.

SUPPORTED BY U.S. Atomic Energy Commission

6.0043, GROWTH AND TOXICOGENESIS OF C. BOTULINUM IN FISHERY PRODUCTS

J.T. GRAIKOSKI, U.S. Dept. of Interior, Technological Laboratory, *Ann Arbor, Michigan*

The objective of this project is a study of the growth of C. botulinum type E, in reference to all spore forming organisms (those organisms important in the design of processing parameters). Growth involves the germination of the spore, proliferation of the vegetative cell with toxin synthesis, subsequent sporulation, and a period of spore dormancy. Dormancy also involves the unique characteristic of spore resistance. The development and evaluation of agents which inhibit and/or kill the organism is an integral part of growth studies, i.e., antimetabolites. This aspect is of importance in the development of proper sanitation procedures.

Basic to this study is the development of methodology for measuring growth requirements and the end products of metabolism, including the toxin.

Portions of the research are carried out under contract.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0044, EFFECTS OF HANDLING AND PROCESSING PROCEDURES IN POTENTIAL PATHOGENUS ON FISH

J.T. GRAIKOSKI, U.S. Dept. of Interior, Technological Laboratory, *Ann Arbor, Michigan*

Research in this project is directed toward a determination of the effects of processing and handling procedures on the survival, growth, and toxicogenesis of C. botulinum and other potentially pathogenic or toxicogenic organisms which may be found in fishery products. The next step in this research sequence is to develop and recommend processing and handling techniques which will produce fishery products of acceptable quality that are safe for human consumption. The most immediate problems under this project are to assess the current degree of risk to the public from smoked fish consumption caused by the presence of C. botulinum (particularly type E) and to develop smoked fish processing guidelines that allow a margin of safety to the consumer.

In reference to smoked fish processing, the establishment of methodology for the standardized production of a quality smoked fish is being developed, since knowledge in this area is completely lacking even within industry itself. In the present phase of the project, the primary emphasis is being placed on the processing parameters for the production of smoked whitefish chub of uniform quality. Concurrently, the effect of know inhibitors of C. botulinum outgrowth are being evaluated for type E strains (NaCl, NaNO2, organic acids, etc.).

In respect to control of botulism in smoked fishery products, the heat resistance of C. botulinum type E spores is being studied in phosphate buffer and in fish flesh. The influence of hydrogen ions, sodium chloride, nitrite, nisin, and other inhibitors on the heat resistance of the spores in fish flesh is being compared. The outgrowth potential of botulinum type E spores at various incubation temperatures and in the presence of sodium chloride, nitrite, antibiotics, and various hydrogen ion concentration is being determined. Portions of the research are carried out by contract.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0045, CONTROL OF OXIDATIVE CHANGES IN FRESHWATER FISH

R.A. GREIG, U.S. Dept. of Interior, Technological Laboratory, *Ann Arbor, Michigan*

The primary objective of this project is to determine methods for significantly improving the frozen storage capabilities of freshwater fishery products. Investigations to fulfill this objective have been centered on controlling the onset of oxidative rancidity during frozen storage of these products. Investigations on controlling other quality deterioration factors--such as off-color development--will also be emphasized.

A secondary objective is to evaluate possible chemical methods for objectively following the above mentioned quality deterioration factors in frozen freshwater fishery products.

Frozen storage tests on various freshwater fish products were broadened to include basic investigations to determine the mechanisms of lipid oxidation in freshwater fish, a limiting problem in extending the frozen storage of many species. Particular attention is being paid to the catalytic factors involved and methods to block these.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0046, COMPOSITION STUDIES OF FISH AND SHELLFISH AS RELATED TO STORAGE AND PROCESSING PROBLEMS

R.N. FARRAGUT, U.S. Dept. of Interior, Technological Laboratory, *Pascagoula, Mississippi*

Work undertaken under this project will attempt to relate differences in composition of various fish and shellfish to problems encountered in the handling, processing, and storage of the product. Differences in composition from species to species can be related to the appearance of particular problems in the handling of the species. An attempt will be made to utilize specialized knowledge of compositional factors in solving technical problems in order to increase the consumption of that particular product. Specific problems on hand include, but are not limited to: browning discoloration of cut surfaces and skin of snapper and grouper steaks and fillets during frozen storage; development of rancidity in frozen Spanish mackerel; discoloration of processed crab meat; and skin shrinkage upon cooking of certain species of snapper. The effects of various antioxidants, chelating agents, packaging atmospheres, and packaging materials will be investigated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0047, PROCESSING AND PRODUCT DEVELOPMENT OF EDIBLE FISH AND SHELLFISH

R.N. FARRAGUT, U.S. Dept. of Interior, Technological Laboratory, *Pascagoula, Mississippi*

The first phase of this work will be concerned with the development of new products and processing methods for the several additional red snapper species--a new resource delineated by Exploratory Fishing and Gear Research.

The second phase, to be carried out concurrently with the first and to be financed by Army Research Laboratories contract, will be to develop a product(s) suitable for irradiation sterilization processing. Others to be included are, but not limited to, the mackerel, oyster, clam, blue crab, mullet, and grouper fisheries.

a. In cooperation with Exploratory Fishing and Gear Research, Pascagoula Fisheries Station, fisheries with large potential will be delineated. b. Suitable products, processes, and packages will be investigated. c. The product, process, and package most suitable for particular markets (institutional vs. retail) will be selected and produced in cooperation with retail industry. d. Through the cooperative effort of the Branch of Marketing, suitability and marketability of the product will be tested. e. Information gathered will be made known to industry through oral, audio-visual, and written communications.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0048, CHEMICAL REACTIONS IN PROCESSED SEAFOODS

H.C. THOMPSON, U.S. Dept. of Interior, Technological Laboratory, *Pascagoula, Mississippi*

Changes, occurring during the storage and processing of seafoods, in the basic biochemical and physiological make-up of seafood products contribute both evident and non-evident changes in quality of the product as it reaches the consumer. The objective of this project is to define the changes and the mechanism(s) underlying these changes. Possession of the basic facts concerning changes in quality will thus enable logical and scientific correction of storage and processing procedures to ensure a better quality product.

Work is underway in defining the basic mechanism(s) concerned in the iron sulfide discoloration of canned shrimp. Although this problem appears to be related to pH of the raw and processed material, research has indicated that this is a superficial answer and that changes in the basic structure of a protein or other biochemical constituent during iced storage allows the binding of tin ions from tin plate.

Further work is being done presently on changes occurring during iced storage of shrimp which result in altered texture of the finished product. In this connection, the possibility of alteration in the chemical and physiological structure of the connective tissue proteins is being investigated.

Other problems to be considered in the future are: The loss of protein-bound water and its effect on texture, the connection of protein denaturation with toughness in texture, the effect of bacterial enzymes on quality deterioration in seafoods.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0049, CONTAINERIZATION OF FISHERY PRODUCTS

M.E. WATERS, U.S. Dept. of Interior, Technological Laboratory, *Pascagoula, Mississippi*

The containerization of shrimp, on shore and at sea, will form the first phase of this work. Subsequent investigations will include, but are not limited to, the menhaden and industrial fish fisheries.

a. Efficient containers will be selected and evaluated first in the laboratory and then in the field. b. Demonstrations of efficiency and consequent economic gain will be made to the industry via audio-visual techniques.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0050, CHEMICAL AND MICROBIOLOGICAL APPLICATIONS TO PRODUCT ENGINEERING

B.J. WOOD, U.S. Dept. of Interior, Technological Laboratory, *Pascagoula, Mississippi*

Work undertaken in this product will attempt to relate scientific principles to the solving of technical industrial problems. Better methods of producing, handling, and transporting fishery products will be devised. Adaptation of advances made by other segments of the food industry will be made for use with fishery products as the starting medium. New products, processes, and concepts in handling will be experimented with. Specific points include, but are not limited to: containerization of iced stored shrimp; development of a satisfactory method of freezing raw oysters; development of means of reducing bacteria present in fishery products; development of an on-board shrimp heading machine; development of methods to increase iced storage life of shrimp; and development of techniques for processing industrial fish at sea.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0051, DEVELOPMENT OF MECHANIZATION DEVICE PROTOTYPES

B.J. WOOD, U.S. Dept. of Interior, Technological Laboratory, *Pascagoula, Mississippi*

The first phase of this project will deal with the development of an onboard fish press that will reduce the moisture content of certain species of fish by as much as 50 percent. The resulting product will be suitable for processing into pet food, fish meal, or fish protein concentrate. Other devices to mechanize the handling of fish and shellfish will constitute subsequent phases and will include, but not limited to, a shrimp deheading device, fish filleting and handling devices, etc.

a. Develop prototype mechanization devices. b. Test prototype and product therefrom. c. Contract wtih reputable engineering firm to design final version of the device.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0052, ENTERIC BACTERIA AND VIRUSES IN SEWAGE, WATER, AND SHELLFISH

L.W. SLANETZ, Univ. of New Hampshire, Graduate School, *Durham, New Hampshire* 03824

Studies will be continued on the correlation of numbers of coliforms, fecal coliforms, and fecal streptococci with the presence of salmonellae and enteroviruses in seawater and oyster samples collected from stations in our bay and estuarine areas. Particular attention will be given to the detection of salmonellae and viruses in oysters harvested from shellfish growing waters considered to be of approved sanitary quality based on recommended coliform standards. Hydrographic conditions in the study areas will be determined to establish the possible impact of such conditions on the microbiological data obtained. Studies will also be continued to assess the efficiency of newly installed sewage treatment plants in eliminating enteric bacteria and enteroviruses in seawater and shellfish at sampling stations in several estuarine and bay areas. The effectiveness of depuration procedures for providing shellfish of acceptable microbiological quality will be determined using shellfish harboring indicator bacteria, salmonellae, and enteroviruses.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0053, BIOCHEMISTRY OF FISH AS RELATED TO HUMAN NUTRITION

A.E. TERRI, Univ. of New Hampshire, Agricultural Experiment Sta., *Durham, New Hampshire* 03824

Objectives: 1. To investigate release of hypoxanthine from the breakdown of muscle ATP, with a view to expanding use of this reaction for estimating freshness and potential storage life of fish as food for humans. 2. To investigate fish as a source of amides from amino acids essential for humans.

Work Proposed: 1. Species of fish commonly consumed in the New England area will be analyzed for hypoxanthine which results from the breakdown of muscle ATP. The relationship between free hypoxanthine and storage time will be studied, and an attempt made to use the procedure for estimating future storage life of various specimens. 2. In the studies with amino acid amides, standard synthetic organic (ammonolysis of amino acid esters), and chromatographic methods will be employed. The chromatography work will involve investigation of numerous solvent systems in an attempt to define one which is efficient for chromatographic separation and identification of amides. If development of an analytical method is successful it will be used for investigation of these compounds in various marine species.

SUPPORTED BY U.S. Dept. of Agriculture
New Hampshire State Government

6.0054, NUTRITIVE VALUE OF FISH AND OTHER MARINE PRODUCTS

A.E. TERRI, Univ. of New Hampshire, Agricultural Experiment Sta., *Durham, New Hampshire* 03824

The objective of the project is to determine the nutritive value with respect to water soluble vitamins, and amino acids, of fish and other marine products such as lobsters, clams and oysters. Various species have been analyzed quantitatively for several of the B-vitamins. This work is continuing with respect to thiamine and ascorbic acid. Various species have been analyzed qualitatively, by means of paper chromatography, for their free amino acids, and proteins. Present, and future work involves development and improvement of quantitative chromatographic amino acid analyses, and their application to various fish species.

SUPPORTED BY New Hampshire State Government

6.0055, FERMENTED PROTEIN-RICH FOODS

A.G. VANVEEN, Cornell University, Graduate School, *Ithaca, New York*

A need exists for cheap, digestible, nutritious and acceptable protein-rich foods to combat protein malnutrition which is prevalent in many areas in the world.

So-called 'fermented foods' from soybeans, peanuts, grain legumes, fish, spices, and milk fall in this category (and a similar microbiological treatment might be applied to some other commodities such as sources of leaf protein). There is no acceptability problem with these fermented foods in areas where they are known, but this acceptability is usually a serious problem with 'new' and unknown protein-rich foods.

Microbiological, biochemical and nutritional research of these products has been very incomplete and the presence of mycotoxins will have to be investigated. There is a great need for the improvement and standardization of nutritive quality, the microbiological properties, and improvement of the stability.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0056, BACTERIAL INDICATORS OF THE SANITARY QUALITY OF DEPURATED HARD CLAMS, MERCENARIA MERCENARIA

G. STROBEL, State Conservation Department, *Oakdale - Long Island, New York*

This phase will be undertaken to obtain an adequate and rapidly determined bacterial indicator of the sanitary quality of depurated hard clams, Marcenaria marcenaria, to insure a wholesome food product and avoid unnecessary storage after processing.

Tests will be performed using known and standard techniques to gather information on changes of the Standard Plate Count, Coliform and Fecal Coliform Group, Escherichia coli Type I, Fecal Streptococci, and Clostridium species in hard clams before, during and after the depuration process.

Data will be evaluated and that bacterial indicator selected which most nearly fulfills the objectives of this phase.

Work will commence immediately and continue for the duration of the project.

All laboratory studies will be conducted at the New York State Conservation Department, Oakdale on samples taken from the Depuration Plant, West Sayville, New York.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
New York State Government

6.0057, ENTEROVIRUSES IN DEPURATED HARD CLAMS, MERCENARIA MERCENARIA

G. STROBEL, State Div. of Fish & Game, *Oakdale - Long Island, New York* 11769

The purpose of this phase is: 1) To survey hard clams from moderately polluted waters of Long Island for enterviruses (Polio Types I, II, and III; Coxsackie B Types; ECHO). 2) To observe release rate of enteroviruses in hard clams during the depuration process, and thus obtain information on the efficacy of the process for virus removal.

Samples will be collected from the Depuration Plant, West Sayville, New York and examined for the presence of viruses in the Department of Biology, State University of New York at Stoney Brook, New York.

Hard clam samples will be homogenized and rendered bacteriologically sterile with antibiotics and high speed centrifugation. Viruses will be detected using an indicator system of commercially purchased Rhesus monkey kidney monolayer cell culture tubes. Inoculated tubes will be observed during 10-14 days incubation for viral cytopathogenic effects.

Release data will be evaluated in conjunction with the bacterial studies to determine if any correlation exists between the bacterial release rates and the viral release rates.

Work will commence immediately and continue for the duration of the project.

Part 2 of 5.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
New York State Government

6.0058, EVALUATION OF PARAMETERS OF OPERATION

G. STROBEL, State Div. of Fish & Game, *Oakdale - Long Island, New York* 11769

This phase will concern an evaluation of those parameters which significantly effect the depuration process for the hard clam Mercenaria mercenaria, and which may be controlled. The objective will be to determine optimum conditions of operation so that realistic specifications may be developed. The effect of these parameters will be evaluated based on the reduction of bacterial contaminates as measured by the standard indicator tests for sanitary quality.

The parameters to be evaluated are salinity, turbidity, temperature, flow rate, recirculation factor, and dissolved oxygen. Individual variation and past history will also be evaluated as to source, level, and nature of original contamination, and the time lag between harvesting and processing. Plankton, Phosporous and Nitrogen content and distribution of the process water will be meausred also to determine the effect of variations in these factors on the process. Seasonal variations exhibited by the clams will also be evaluated.

Experiments will be run concurrently to determine the effect of each variable. These tests will be repeated periodically throughout the year to test for seasonal variations.

Procedures and techniques will follow those given in 'Standard Methods for the Examination of Shellfish and Sea Water' for bacteriological work and 'Standard Methods for Water and Waste Water' for chemical examinations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
New York State Government

6.0059, EFFECT OF PROCESS ON SHELLFISH

G. STROBEL, State Div. of Fish & Game, *Oakdale - Long Island, New York* 11769

Some concern has been raised about the effects of the process on the value of the clam with particular emphases on shelf-life. Local dealers claim that clams harvested during the time of year when they are emerging from hibernation have a shorter shelf-life than those taken during the rest of the year. Since plants will have to operate during the winter months, and since economics will play a major role in determining the feasibility of such a process, it is necessary to determine any effects of depuration on market value.

Work on this phase will start immediately and continue for one year to determine any seasonal variations.

Work will be performed at the plant in West Sayville, N.Y. with laboratory tests performed in the State laboratory at Oakdale, L.I., using established techniques.

Part 5 of 5.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
New York State Government

6.0060, RESEARCH AND GRADUATE TRAINING IN FOOD AND DRUGS FROM THE SEA, AND MARINE POLLUTION

O.A. ROELS, Columbia University, Graduate School, *Palisades, New York* 10964

Applied biological research will be expanded in three main areas, Food from the Sea, Drugs from the Sea, and Detection of Marine Pollution.

Under the Food from the Sea category, work will be expanded on the fermentation of trash fish for the development of foods suitable for human use, and the isolation of marine proteins to produce hydrolysates and protein isolates suitable for human consumption. In the Drugs from the Sea studies, new antibiotics and potential anticancer agents will be isolated, and their structure and synthesis defined. The Pollution Studies are intended to devise novel systems of detecting marine pollution and ways of monitoring and relieving its undesirable effects on the environment. The initial effort will be to determine the influence of effluents from the land upon the water masses between Montauk Point and the Chesapeake Bay with particular emphasis on the influence of Long Island Sound, the Hudson River, the Delaware and the Chesapeake.

SUPPORTED BY U.S. National Science Foundation

6.0061, THE EFFECT OF PROCESSING VARIABLES ON THE QUALITY OF MEAT FROM THE BLUE CRAB - CALLINECTES SAPIDUS

W.A. THOMSON, Univ. of North Carolina, Agricultural Experiment Sta. , *Raleigh, North Carolina* 27600

This study would compare the quality of pasteurized and non- pasteurized crab meat with respect to the type of meat and the original physical condition of the crab. An attempt to reduce the possibility of thermal damage to crabmeat during pasteurization would be made by means of addition of fluids such as edible oils and aqueous solutions of inorganic salts, acids, chelating agents, etc. to the canned meat. Methods of study will include flavor and texture evaluation, color measurement and examination of bacterial populations.

SUPPORTED BY North Carolina State Government

6.0062, EFFECT OF STORAGE ON FISH MUSCLE PROTEINS

N.B. WEBB, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600

The objectives of this project are to evaluate the methods of analysis and determine the effect of changes in emulsifying capacity, visosity, water-binding capacity, texture and rheological properties and protein solubility of fish and/or shell fish muscle proteins during post-mortem storage. Furthermore, the characteristics of these basic properties of muscle proteins are to be used in developing the functional aspects of seafood products. The experimental work is to entail the evaluation of muscle protein changes in relation to microbiological level, time of storage and temperature of storage. Subsequently, these findings are to be used as a basis to manufacture comminuted prefabricated seafood products.

SUPPORTED BY North Carolina State Government

6.0063, SURVIVAL OF FOOD PATHOGENS IN RADIATION PASTEURIZATION SEAFOOD

A.W. ANDERSON, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Studies were conducted under controlled conditions in order to observe the resultant survival patterns in solid crabmeat and in Hartsell's broth of Salmonella enteriditis, S. paratyphi A, S. cholerasuis, S. pullorum, streptococcus pyogenes, and Staphylococcus aureus after individual exposure to Co 60 irradiation. A 'tailing off' was found in the survival patterns of S. paratyphi A, S. pullorum, S. enteriditis, and S. aureus when irradiated in crabmeat, but was not found upon exposure in Hartsell's broth. However, S. cholerasuis and S. pyogenes showed a definite 'tailing off' in the broth while only weakly, if any, in the crabmeat. Thus this 'tailing off' phenomenon cannot be explained as a mere effect of the medium, but rather indicates a much more complex situation. The results indicate that predictable pasteurization doses usually based on D values would be quite inaccurate, since the projection is based on sigmoidal and linear inactivation curves.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0064, DEVELOPMENT OF THE SHAD INDUSTRY

D.L. CRAWFORD, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

Objectives: (1) Develop new products consistent with the unique characteristics of shad. (2) Improve the quality of shad processed by usual methods. (3) Investigate the utilization of shad by-products. (4) Determine the potential United States market for fresh Pacific shad in areas not presently supplied. New products utilizing shad such as precooked frozen products and such items as fish sausage of various kinds will be developed. Procedures used in canning herring, sardines and anchovies will be adapted to shad. Processing variables such as time and temperature and factors such as sex, moisture and fat content on the final texture and acceptability will be investigated. The effect of pre-processing procedures such as brining and application of polyphosphates as firming agents will be determined. Conventional means of processing shad such as mild curing, smoking, kippering, pickling and freezing will be investigated. The effect and value of certain additives including antioxidants will be investigated for possible use in processing shad. The potential of expansion and extension of the marketing of fresh Pacific shad into areas not presently supplied will be investigated. The suitability of the by- products of the shad industry for animal, fish and pet food will be determined.

SUPPORTED BY Oregon State Government

6.0065, DEVELOPMENT OF NEW HUMAN FOOD PRODUCTS FROM SHAD

E.W. HARVEY, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

Objectives: Develop new products consistent with the unique characteristics of shad; examples: fish sausage, fish loaf of the luncheon type, pepperoni, etc.

Procedures: A fish sausage using shad as the major component will be developed using condiments which are commonly associated with pork sausage, frankfurthers, salamis, etc. Fish of the Sebastodes grouping, which are in abundant supply off our coastal waters will be the complimentary fish used with shad to formulate the fish sausage. Incorporation of cereals and other fish items will be used to improve texture. Methods for removal or comminution of objectionable bone particles will be investigated. Casings of various types including both artificial and natural will be tried. Fish loaf samples using artificial as well as natural smoke will be prepared. Partial economics of the operation will be determined through records of ingredient cost and yields. A close monitoring to determine keeping qualities and bacterial load will be conducted. Samples will be submitted to taste panel for consumer acceptance tests.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Oregon State Government

6.0066, PREPARATION OF FISH PROTEIN HYDROLYSATES

D.K. LAW, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

Objectives: To develop a method of preparing protein hydrolysate from fish scraps and by-products including hake and dogfish.

Procedures: A procedure used to pasteurize salmon viscera will be adapted to digest hake, dogfish and other fish. Time and temperature relationships will be studied to determine optimums. Methods for bone and oil separation will be studied. A high degree of protein solubility may occur with no particular increase in free amino groups. Formol titration and other appropriate chemical methods will be used to determine the degree of proteolysis. Proximate analysis of the protein hydrolysates will be determined. Their nutritive value will be determined in preliminary studies with suitable test animals including rats.

Work Schedule: For the remainder of the fiscal year (approximately from Feb. salmon viscera will be adapted to digest hake, dogfish and other fish scrap. Optimum time and temperature relationships for this process will be determined.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Oregon State Government

6.0067, UTILIZATION OF HAKE, DOGFISH, AND BY-PRODUCTS OF THE FILLET INDUSTRY FOR PROTEIN SUPPLEMENTS

D.K. LAW, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

Objectives: (1) Develop fish protein hydrolysates from fish scraps and by-products including hake and dogfish. (2) Prepare and evaluate high quality fish meals made from hake, dogfish, and by products of the fillet industry. (3) Investigate procedures for heat pasteurization and acidification of hake which will yield a stable protein product.

Hake, dogfish, and other fish scrap will be digested utilizing the natural autolytic and digestive enzymes in fish and possibly certain vegetable proteolytic enzymes. Time and temperature relationships will be studied to determine optimums. Methods of bone and oil separation will be investigated. Uses for these hydrolysate products will be investigated and evaluated. Fish meal of hake, dogfish, and other fish scraps will be prepared and evaluated both chemically and nutritionally. The use of antioxidants will be investigated. Procedures will be developed for pasteurization of hake and dogfish. The addition of various acids to this pasteurized product to achieve a stable product which can be stored at room temperature will be investigated. The storage stability of these products and the value of antioxidants for prevention of fat oxidation will be determined.

SUPPORTED BY Oregon State Government

6.0068, UTILIZATION OF LATENT MARINE RESOURCES AND WASTE PRODUCTS

D.K. LAW, Oregon State University, Agricultural Experiment Sta. , *Corvallis, Oregon* 97331

Objective: To investigate the latent marine resources and available waste products as sources of protein and other nutrients for use in animal and human nutrition. A method for production of a low- fat marine protein concentrate from hake and other latent species will be developed. The marine protein concentrate will be evaluated as a source of protein for use in human nutrition. Procedures will be developed for processing and storing shrimp and crab scrap. Its nutritive value as a supplement in trout rations will be evaluated. Acidification as a means of preserving whole ground fish for use as an animal feed will be investigated. Use of latent marine resources such as anchovy, silver smelt, krill, etc., for use as human and animal food, will be investigated.

SUPPORTED BY Oregon State Government

6.0069, SURVIVAL MECHANISM OF IRRADIATED BACTERIA IN FOODS

J.S. LEE, Oregon State University, Agricultural Experiment Sta. , *Corvallis, Oregon* 97331

Objectives - (1) Examine and describe the nature of the changes that occur in microorganisms that have received sub-lethal doses of radiation. (2) Investigate the action of certain food additives and bacteriostatic agents on radiation injured microorganisms. (3) Investigate the effect of radiation on microorganisms according to the physiological or genetic parameters, e.g., permeability changes, DNA degradation, capability to produce exo or endo toxins, antibiotics sensitivity and morphological or taxonomic variations.

Select group of microorganisms will be studied in order to demonstrate the nature and extent of sub-lethal radiation damage. We have already demonstrated this in Escherichia coli B. (1) This will be extended into other bacteria that survive irradiated foods in a significant number. We will initiate our investigation with Achrombacter species that survive in irradiated Dover sole, Dungeness crabmeat and in Pacific oysters. (2) The sub-lethally damaged cells can be isolated from the non-injured cells by the penicillin technique. A threshold concentration of penicillin may be incorporated in the basal media for the initial recovery of radiation survivors. After incubation to permit the growth of healthy cells which then are inactivated by penicillin the plates will be overlayed with complete media. This will dilute the penicillin and also permit the growth of cells that did not grow on the basal media. These colonies will be investigated for their physiological and genetic variations.

SUPPORTED BY Oregon State Government

6.0070, SURVIVAL MECHANISM OF IRRADIATED MICROORGANISMS IN FOOD

J.S. LEE, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

Ionizing radiation of food is being accepted as an extended method of preserving man's food supply. A further understanding of the action of radiation on food-borne microorganisms, at the cellular level, is the subject area of this proposal.

This proposal intends to investigate the nature of change that occurs in sub-lethally injured microorganisms due to irradiation. Several food preservatives such as sodium benzoate, potassium sorbate and sodium chloride have been shown to exert different effects on radiation injured bacteria than to the unirradiated cells. In irradiated sea-foods, for example, the recovery rates of survivors at 7 degrees C were further reduced by 0.1% sodium benzoate. The irradiated Salmonella typhimurium and S. enteritidis, on the other hand, remained viable for longer periods of time at 7 degrees C when 0.1% sodium benzoate was present.

The mode of action of such food additives and other bacteriostatic agents on the radiation injured bacteria will be determined by measuring the cellular functions following irradiation. Respiration, catabolic incorporation of nutrients and the specific effects of the preservatives can be determined by manometric methods. The suspected change in permeability, degradation of macromolecules or inhibition of their synthesis can be determined by the use of radioisotopes. Other changes that will be examined will include capability to produce toxins, sensitivity to antimicrobial agents and morphological and taxonomic variations.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0071, LIPID OXIDATION AND ASSOCIATED BIOCHEMICAL CHANGES OCCURRING DURING THE PROCESSING AND STORAGE OF FISHERY PRODUCTS

R.O. SINNHUBER, Oregon State University, Agricultural Experiment Sta. , *Corvallis, Oregon* 97331

1. Investigation of objective methods for the determination of quality of fishery products. 2. Determination of oxidative rancidity by chemical or physical means. 3. Investigation of changes which occur in lipids during processing and storage. 4. Investigations of antioxidants and their role in the prevention of oxidative rancidity.

Changes in the lipid portion of seafoods will be followed by applying or developing certain chemical tests and correlating these results with sensory evaluation. Techniques to be used are the indole and picric acid methods and the 2-thiobarbituric (TBA) acid, peroxide and carbonyl determinations will be modified to permit their application to a greater variety of processed seafood products. The Sanger technique will be used to follow reactions between the protein and carbonyl groups of lipid oxidation as related to browning of stored fishery products. The effect of antioxidants in stabilizing the lipid portions of seafood products will be determined by application of the above techniques and by the celite method for accelerated tests.

SUPPORTED BY Oregon State Government

6.0072, INVESTIGATE THE EFFECT OF IRRADIATION ON THE MICROBIAL FLORA SURVIVING IRRADIATION PASTEURIZATION OF SEAFOODS

R.O. SINNHUBER, Oregon State University, Agricultural Experiment Sta. , *Corvallis, Oregon* 97331

1. Study the shift in the natural microbial flora (including yeasts and molds) due to the variation in irradiation resistance and determine a) the spoilage by these microorganisms, b) their pathogenicity. 2. Determine whether a significant number of those microorganisms which survive are mutants, and their role if any in spoilage. 3. Investigate the complimentary effects of approved food additives such as nitrites, nitrates, sodium chloride, and possibly other radiolethal agents.

By taste panel methods the maximum allowable radiation dose will be determined. The kinds, types, and pathogenicity of the surviving microorganisms will be ascertained by conventional methods. The normal microbial flora and spoilage pattern as well as that which results after radiation and storage will be followed by chemical and microbiological techniques.

SUPPORTED BY Oregon State Government

6.0073, DEVELOPMENT OF RADIATION STERILIZED FISH ITEMS FOR ARMED FORCES FEEDING

R.O. SINNHUBER, Oregon State University, Agricultural Experiment Sta. , *Corvallis, Oregon* 97331

1. Conduct studies to determine optimum conditions for producing acceptable irradiation sterilized seafood products that will remain stable at ambient temperature. 2. The species shall include but not be limited to cod and halibut. 3. The influence of the following processing variables will be studied: a) selected additives, b) antioxidants, c) odor scavengers, d) Oxygen scavengers, e) packaging environment, f) Cooking procedures and use of condiments at time of serving for evaluation. 4. Sufficient samples shall be prepared to permit periodic examination of the over a period of 9 months. The storage temperature will be 72 degrees F. Large consumer type acceptance panel evaluation will be made of the various treatments using proven psychological methods with adequate controls and statistical evaluation of the results. Appropriate chemical tests will be made to determine the changes that occurs during storage and to correlate these findings with panel evaluation.

SUPPORTED BY Oregon State Government

6. PUBLIC HEALTH AND SAFETY

6.0074, STORAGE STABILITY STUDIES ON RADIATION STERILIZED FISH ITEMS

UNKNOWN, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

1. To determine cause of 'browning' and other changes that occur during storage of irradiated fish items. 2. To develop methods for controlling these changes that adversely effect the products.

1. Studies on carbonylamine reactions, the production of carbonyl compounds from carbohydrates and unsaturated lipids, the production of amines from protein, and the effect of irradiation at sub-freezing temperature (-80 degrees Centigrade). 2. Studies on the use of selected 'browning' inhibitors, antioxidants and various packing procedures using appropriate chemical and physical techniques. 3. The various treatments will be evaluated by subjective panel evaluations after storage at 22 degrees Centigrade over a period of 12 months.

SUPPORTED BY Oregon State Government

6.0075, VITAMIN K5 AS A FOOD PRESERVATIVE

H.Y. YANG, Oregon State University, Agricultural Experiment Sta., *Corvallis Oregon* 97331

1. To study the inhibiting action of Vitamin K5 against various food spoilage microorganisms.

The effect of vitamin K5 on the microorganisms isolated from meats, seafoods, fruits and vegetables will be studied. Two or three foods from each group will be used as representative samples. Vitamin K5 in the concentrations ranging from 10 to 1000 ppm will be added to these organisms and their survival will be observed. The combined effect of vitamin K5 and other food preservation methods on microorganisms will be studied using various concentrations of vitamin K5 in combination with canning, freezing, dehydration, and irradiation techniques and determining the effect of the combined process on the survival of the microorganisms.

SUPPORTED BY Oregon State Government

6.0076, THE COMPOSITION, NUTRITIVE VALUE AND QUALITY OF FISHERY PRODUCTS WITH SPECIAL EMPHASIS ON LIPID AND ITS INTERACTION

T.C. YU, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

Objectives: 1. Extend the storage life of frozen seafood products. 2. Improve nutritive value and to prolong the storage life of fish meal and fish flour. 3. Stabilize lipids in irradiated fishery products. 4. Investigate the role of polyunsaturated fatty acids (fish oils) in animal growth. 5. Develop and improve chemical methods for testing the quality of fishery products.

The effectiveness of various antioxidants in the protection of frozen seafoods (also fish meals) from oxidative deterioration and methods of incorporating antioxidants to fish will be investigated. Packaging material having least air permeability and highest protection of the products against desiccation will be sought. Factors causing the development of browning discoloration of the irradiated fishery products by means of inhibiting these adverse reactions will be investigated. The experiments designed to study the role of polyunsaturated fatty acids in fish growth will be conducted to utilize the existing fish rearing facilities of the Food Toxicology and Nutrition Laboratory using rainbow trout as test animal.

SUPPORTED BY Oregon State Government

6.0077, THE STORAGE LIFE OF ICED DEEP SEA RED CRABS - GERYON QUINQUEDENS

A. HOLMSEN, Univ. of Rhode Island, Agricultural Experiment Sta., *Kingston, Rhode Island* 02881

Justification: The red crab is caught in large quantities by the deep sea lobster trawlers. It has a delicate flavor and a good dressing percentage, but since it can not be stored in lobster tanks it is thrown overboard.

Objective: To determine the keeping quality of iced crabs and the effect of icing on the texture of the meat.

Procedure: On board a trawler various ways of icing crabs will be tried (iced in the hull, iced in burlap bags, vegetable bags etc.). The crabs will be stored for various lengths of time from one to ten days, and bacteriological test will be carried out to determine the effect on quality of handling, temperature, and length of storage.

SUPPORTED BY Rhode Island State Government

6.0078, THE STRUCTURE OF DECISION MAKING IN MAJOR MARKETING AGENCIES OF FOOD FISH IN THE N.E. UNITED STATES

H.C. LAMPE, Univ. of Rhode Island, Agricultural Experiment Sta., *Kingston, Rhode Island* 02881

Objectives: (1) To determine the variables controlling decisions in the purchase, processing, and distribution of food fish in the existing market system; including: short run factors regarding volume, variety, source, and prices; effect of existing market restraints on the scope of decisions; evaluation of the information leading to decisions; and examining the effect of firm policy on the scope of decisions by those responsible for the purchase, sale, and distribution of food fish. (2) To determine changes necessary in the structure in order to effect changes in the market process for food fish; with particular attention to the importance of reducing costs as an inducement to change, and the possibility of changes in decision making structure as regards marketing.

Work Proposed: (1) From secondary and primary sources develop a complete description of the channels of trade to determine: the volumes of fish of various species moving through; to evaluate the relations between imports, cold storage holdings and catch volume; to examine the price-quantity relations among relations among various species. (2) To survey industry representatives (wholesalers, manufacturers and chain store buyers regarding the importance of species, prices, quality, and quantity of fish purchases.

SUPPORTED BY Rhode Island State Government

6.0079, MARKETING EFFICIENCY IN A COOPERATIVE FOOD-FISH PROCESSING PLANT, A CASE STUDY

H.C. LAMPE, Univ. of Rhode Island, Agricultural Experiment Sta., *Kingston, Rhode Island* 02881

Objectives: To discover and identify inefficient product handling and processing in a cooperative multiple product, fish food processing plant; to develop and recommend alternative methods of processing and product handling as a means of reducing marketing costs; to analyze and recommend changes in plant and equipment that will improve the operating efficiency of a given plant.

Methods and Procedures: The plant operations will be divided into definite job series, and the jobs will be further subdivided into operations; general production study will be conducted for each operation and for each job; a detailed production study will be conducted on the freezing storage and shipment aspect of the plant; partial budgeting and/or linear programming will be used to evaluate the potential of various alternative approaches to resolving production problems where inefficiencies are discovered.

SUPPORTED BY Rhode Island State Government

6.0080, PROCESS ENGINEERING

J.A. DYER, U.S. Dept. of Interior, Technology Laboratory, *Seattle, Washington*

This project is designed to study the application of chemical engineering processes to the production and utilization of fish oils. The current project is the production of high-grade fish oil from the solvent processes used to produce fish protein concentrate.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0081, OUTGROWTH OF CLOSTRIDIUM BOTULINUM TYPE E IN NONIRRADIATED AND IRRADIATED FISHERY PRODUCTS

M.W. EKLUND, U.S. Dept. of Interior, Technology Laboratory, *Seattle, Washington* (AT(49-7)2442)

Objective: During a study of the incidence and concentration of Clostridium botulinum type E cells in the marine environment, strains of nonproteolytic types B and F were isolated from the Pacific Coast of the United States. Both of these types are uncommon to the North American continent and only a few pure cultures of this type exist in the world. Since these cultures were isolated from the marine environment, it is very important that the physiological and biochemical characteristics of these strains be studied to determine whether they are of any greater public health significance than type E in irradiated fishery products held at refrigerated temperatures.

Results to date: The physiological and biochemical characteristics of strains of nonproteolytic Clostridium botulinum types B and F are indistinguishable from those of type E. Nonproteolytic types B, E, and F all: 1) produce a protoxin activated by trypsin; 2) produce spores of low thermal resistance; 3) grow and produce toxin at 38 degrees F.; and 4) possess the same cultural, biochemical, and colonial characteristics. The data collected thus far, however, do not indicate that the outgrowth time of types B and F at refrigerated temperatures are of any greater public health significance than that of type E. Antitoxin serums prepared by immunizing rabbits with the toxoid of the nonproteolytic type F isolate do not show any cross-neutralization with the toxins of other known types of C. botulinum. However, approximately 2 to 3 MLD of type of F toxin is cross-neutralized by 1,000 anti-MLD of type E antitoxin. More detailed experiments are currently in progress to evaluate the degree of safety that exists in irradiated fishery products with respect to Clostridium botulinum. The factors responsible for the differences in the outgrowth of type E in petrale sole and haddock fillets are also being investigated.

SUPPORTED BY U.S. Atomic Energy Commission

6.0082, CHEMISTRY OF FISH OILS AND THEIR UTILIZATION

E.J. GAUGLITZ, U.S. Dept. of Interior, Technology Laboratory, *Seattle, Washington*

This project is phased to study the chemical and physical changes that occur during processing, handling, and storage of fish oils that are detrimental to the product quality, and the chemical reactions and procedures that can be used to adapt fish oils or fish oil derivatives to edible usage.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0083, APPLICATION OF RADIATION PASTEURIZATION PROCESSES TO PACIFIC CRAB AND FLOUNDER

D. MIYAUCHI, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Seattle, Washington*

The objective of this work is to develop a practical procedure for the radiation pasteurization of Pacific crab meat, flounder fillets, and related products. The specific tasks are: 1. The determination of the optimum pre- and post-irradiation conditions (sample treatments, radiation dose, storage-life tests, etc.) directed towards defining commercial process parameters. 2. The development of methods for assessing quality for maintaining quality control, and for establishing the safety of the radiation-pasteurized seafoods by sensory microbiological, chemical, and physical tests. 3. The determination of maximum time ('X'-value) for an untrained panel to unanimously reject irradiated fish fillets and relate to the toxin-production time of corresponding irradiated fillets inoculated with spores of Clostridium botulinum type E at various storage temperatures to establish the safety of the irradiation process. 4. The determination of the commercial value of the radiation-pasteurization process by shipping commercial quantities of irradiated fillets through regular commercial channels for evaluation by industry.

SUPPORTED BY U.S. Atomic Energy Commission

6.0084, PRESERVATION AND DEVELOPMENT OF FOOD PRODUCTS

R.W. NELSON, U.S. Dept. of Interior, Technology Laboratory, *Seattle, Washington*

This project involves a continuing study of methods (sensory, chemical, and physical) for determination of the quality of fishery products, the changes due to processing, and the effects of various techniques of preservation. Current subprojects are:

Quality Criteria Development: In connection with other projects and phases of the program research will be conducted on methods of evaluating and assessing the quality of fishery products. The criteria developed will be used in evaluating the effectiveness of preservation and processing variables and treatments for the entire program. Adaptation of color measurement techniques to fishery products evaluation, improved procedures for measuring texture, and rapid methods for measuring salt content are examples of analytical procedures which may be investigated.

New Products from Underutilized Species: Underutilized species will be used in preparing new types of products and in modifying conventional products which will accommodate some of the unusual properties previously considered undesirable. Fish blocks prepared from ground fish tissue of various species will be investigated. Products such as fish cakes, canned smoked products, fish blocks with flavor additives, and canned products with altered flavor and texture will be prepared as means of utilizing species of rockfish, sole, herring, mussels, squid, and others which are not readily acceptable in their present form.

Shellfish Preservation Studies: Research is being conducted on methods of holding and shipping live Dungeness crabs in order to extend market areas farther from the fishing grounds. Procedures for packaging live crabs and maintaining them alive after reaching the destination are being developed. The relationships between time and temperature of holding and crab condition are being studied. The feasibility of air-shipping live crabs from the Pacific Coast to the East Coast is being investigated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0085, STUDY OF THE BASIC MICROBIOLOGICAL AND BIOCHEMICAL FACTORS IN THE IRRADIATION PRESERVATION OF MARINE PRODUCTS

J. LISTON, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

This project represents a continuation of a general investigation of the effects of low dose gamma radiation on the microflora of fish and shellfish and the changes which occur in this flora during subsequent refrigerated storage of the irradiated food. The results achieved previously have confirmed that sequential double irradiation treatments are highly effective in retarding bacterial spoilage of fish fillets. Studies of the nature of radiation damage in S. aureus cells suggest that this effect may be due in part to a sensitizing effect of the primary irradiation exposure. The proposed work is designed to determine optimum conditions for effective double irradiation processes and to relate the procedure to shipboard irradiation of fresh caught fish. Studies will be continued on the identity and physiological properties of microorganisms which multiply on irradiated stored seafood products with the objective of correlating the microbiological changes with chemical changes occurring in the stored foodstuff. Specific studies will be made of the effect of radiation on Vibrio parahaemolyticus which has recently been isolated in the Puget Sound region. An investigation will also be made of the effectiveness of low dose irradiation in eliminating enteric organisms from West Coast shellfish.

SUPPORTED BY U.S. Atomic Energy Commission

6.0086, LOW TEMPERATURE GROWTH OF BACTERIA ON FOODS

J. LISTON, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

This investigation is concerned with the low temperature growth of bacteria on foods. The organisms to be used in these studies will be gram-negative rod-shaped bacteria commonly occurring on seafoods held at low temperatures or which are of public health significance. They will be tested for the occurrence of a growth temperature shift and ability to produce isoenzymes active at low temperatures. Enzyme systems which show activity shifts with lowered temperature will be investigated to determine their temperature optima and confirm or refute the hypothesis that psychrotrophic growth in bacteria is mediated by the cell's ability to produce both mesophilic and psychrophilic enzymes.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0087, BOTULINUM FOOD POISONING IN RELATION TO FISHERY PRODUCTS

E.M. FOSTER, Univ. of Wisconsin, Agricultural Experiment Sta. , *Madison, Wisconsin*

Objectives: To study (1) ecology of C. botulinum type E in the Great Lakes; (2) conditions affecting spore formation by C. botulinum type E; (3) the heat resistance of C. botulinum type E spores with the view of establishing minimum times and temperatures that will destroy the majority of spores without damaging marketability of the product; and (4) to establish conditions necessary to prevent growth of C. botulinum type E fishery products.

Procedure: Samples of fish, water and mud from the Great Lakes will be tested for C. botulinum type E to see if its occurrence can be related to specific environmental conditions. Study cultural conditions of spore formation of C. botulinum, observing effects of nutrients, pH, incubation temperature, and time on sporogenesis. Establish minimum temperature and time which will destroy all heat sensitive spores. Determine efficacy of various food additives for purpose of preventing growth of spores which survive the heat process. Salt, benzoate, nitrite and polyphosphate hold promise. When an effective control procedure is found in the laboratory it will be tried on a pilot scale basis with full size equipment operated under normal commercial conditions. Determine consumer acceptability of finished product by qualified taste panels.

SUPPORTED BY U.S. Dept. of Agriculture
Wisconsin State Government

6.0088, DISTRIBUTION OF C. BOTULINUM IN COMMERCIAL SMOKED FISH

E.M. FOSTER, Univ. of Wisconsin, Agricultural Experiment Sta. , *Madison, Wisconsin*

Outbreaks of type E botulism in 1960 and 1963 have been traced to smoked fish processed in the Great Lakes area. The purpose of this study is to determine the source of C botulinum type E on the fish.

Samples of water, mud and fish from various places in the Great Lakes will be tested for the presence of the type E organism to see if it occurs commonly and, if so, where it exists on or in the fish. Various species of fish will be tested to see if there is a difference in incidence between species. Efforts will be made to determine the natural habitat of the organism if it is found commonly. Concurrently, experiments will be run to evaluate methods of detecting C botulinum type E in natural materials.

SUPPORTED BY Wisconsin State Government

6B. HYPERBARIC MEDICINE AND ADAPTATION

(effects of Deep Oceans on Divers and Habitation)

6.0089, MAN IN THE SEA - VISUAL ACUITY RESEARCH

R.A. CHRISTIANSON, North Amer. Rockwell Corp. , *Long Beach, California* 90803

Experimenters at North American Rockwell's Ocean Systems Operations conducted the initial phases of a research program for testing and measuring the visual responses of divers underwater. Using specially developed techniques and instrumentation, it was found that divers require between 63 and 72 percent more time to perceive and respond to the details of an object when viewed underwater. According to test conclusions, this is partially due to the slight jarring of a diver's head caused by his rising exhalation bubbles, as well as other probable contributing factors. This work was undertaken because divers are being called upon to perform complex underwater-tasks, read instruments in flooded submersibles, and perform a variety of visual search and identification missions where visual perception of objects underwater is of major importance. The project manager, R. A. Christianson, concluded that the technique and instrumentation developed for the visual acuity research was highly successful and will be standardized as a basis for future company experimentation in this area.

The experimental work was conducted at the Diving Research Facility of the University of California at Los Angeles. A technical report, 'A Study of Visual Acuity Underwater Using an Automatic Landolt Ring Presentation Technique', X8-128.020, February 1968, was prepared by Raymond A Christianson.

SUPPORTED BY North American Rockwell Corporation

6.0090, SHARK ATTACKS

L.P. SCHULTZ, Smithsonian Institution, *Washington, District of Columbia* 20560 (NONR)

This work unit provides for the compilation of information on factors relating to shark attacks on humans. These data include geographic distributions of certain shark species and the environmental conditions attending shark attacks. These data are now being analyzed in an effort to form a basis for the prediction of attacks. A central reference file is maintained for the use of investigators in this field. In addition, the Museum's reference collection of sharks and other elasmobranch fishes has been made accessible to researchers by the establishment of special new tanks and hoists which allow easier observation and handling of the large specimens. The shark file is now being prepared for incorporation into a data retrieval system.

It has become evident that the Navy's increasing use of relatively unprotected swimmers and divers in such operational activities as beach reconnaissance, UDT work, and amphibious landings has increased the hazard of encounter by sharks and other obnoxious animals. Demage to morale and the interference with psychological readiness are often equally detrimental to an operation. It is important, therefore, that the extent of the problem in specific geographic areas be evaluated and that as much as possible be learned about the conditions which affect the behavior of sharks. Such information will also serve to guide the chemists and engineers in the development of shark repellents, as well as those who must judge the value of recommended methods.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0091, SEALAB III PARTICIPATION

R.A. WALLER, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Washington, District of Columbia*

The U.S. Navy is exploring the possibilities of having men do useful work from an ambient pressure habitat 620 feet beneath the surface of the ocean off San Clemente Island, California (SeaLab III). As an integral part of this experiment two aquanauts from the Bureau of Commercial Fisheries will, for the first time at this depth, do extended work in marine biology and ecology. The major purpose of BCF participation is to create a cadre of personnel trained in saturation diving techniques and familiar with engineering, design, support, and operations of seafloor habitations. In so doing, the Bureau will be assisting the Navy by providing know-how in marine biology. The participation of the Bureau's diving scientists will also enable them to make a preliminary assessment of the value to research programs of in situ observations and work.

A number of short-term experiments will be undertaken. These include: lobster transplant studies, light attraction studies of fish and invertebrates, observations of fish behavior, species interaction, and light production by biological organisms.

The development of this undersea capability will reveal new avenues of bureau knowledge and radically different methods of ocean harvesting.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0092, METABOLIC ADAPTATION TO COLD

S.K. HONG, Yonsei University, *Seoul, Korea*

Objective: Prof. Hong will continue his studies on cold adaptation of the diving women of Korea which he has been working on for several years in collaboration with Prof. Herman Rahn and Dr. D. W. Rennie of the University of Buffalo. Emphasis in the first phase of this grant will be on regional heat loss during cold water immersion in order to describe more precisely the role of blood flow metabolic rate and insulation in the limbs in relation to the overall body insulation. Measurements will be made simultaneously of trunk and limb heat loss, limb, muscle and skin blood flow and deep muscle temperature.

SUPPORTED BY U.S. Dept. of Defense - Air Force

6.0093, ENVIRONMENTAL PHYSIOLOGY

L. FARHI, State University of New York, School of Medicine, *Buffalo, New York* 14214

Objective: The objective of this program is to increase our knowledge and understanding of the effects of various environmental stresses on Naval and Marine Corps personnel. This research will elucidate and solve some of the biomedical problems of deep submergence associated with the adverse conditions of free swimming and SeaLab type environments.

Approach: The contractor is conducting research, using basic and novel techniques in high pressure physiology to study submergence, deep submergence, increased 'G' forces, and gas exchange in SeaLab type environments. Each of these operational conditions, which is characterized by specific change in one or more of a relatively small number of environmental factors such as gravity, pressure, temperature, breathing atmosphere, or surrounding medium, is being studied. This program will not only investigate how man is affected by these various environmental conditions but also the steps that can be taken to improve performance, extend the limits of exposure, and promote acclimatization.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0094, HUMAN TEMPERATURE REGULATION IN WATER

D.W. RENNIE, State University of New York, School of Medicine, *Buffalo, New York* 14214

It is our broad purpose to study temperature regulation of human beings in a water environment. Emphasis will be upon the effects that exercise in water has upon body heat loss, overall cardiac output and the vascular distribution of blood. Specifically, we propose to measure heart rate, VO2, cardiac output and regional heat loss of man at rest and exercising in water of different temperatures and in different underwater postures. The ventilatory response to exercise in water will be compared to that in air as will the local distribution of blood to exercising limbs.

Basic instrumentation and techniques have been and will continue to be developed on ourselves in the Department of Physiology at Buffalo. These methods will then be applied to a study of cold-acclimatized human beings, the Korean diving women, who have been studied extensively by us in the past in the excellent field laboratory in Pusan, Korea.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0095, THERMAL REGULATION DURING WATER IMMERSION OF MAN

A.B. CRAIG, Univ. of Rochester, School of Medicine, *Rochester, New York* 14627

Water immersion is a physiological stress which affects respiratory, cardiovascular, and thermal regulatory mechanisms. Past investigations in this laboratory have indicated that in man an understanding of the heat exchanges during immersion is fundamental to many other responses. Indirect calculations by methods used for man in air are not applicable to the subject in water.

It is proposed that thermal exchanges and their regulation will be studied using methods of direct calorimetry. A bath calorimeter will be constructed and operated. Heat loss from the bath will be controlled and measurable. Heat input will be from the immersed subject and from electrical heating elements. Therefore, if the bath temperature remains constant, the heat contributed by the subject can be calculated.

This calorimeter will be used to study subjects at rest and during exercise in water of various temperatures. In conjunction with these studies attempts will be made to develop and test methods of indirect calorimetry which would be valid for the immersed subject. In addition we propose certain studies of cardiovascular function which will aid in the understanding of regulation of heat exchanges under these conditions.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0096, MANNED DIVING RESEARCH

H.R. SCHREINER, Ocean Systems Incorporated, *Tonawanda, New York* 14150

Exposure of the deepsea diver to air or synthetic breathing gas mixtures under increased pressure leads to the uptake of inert gases by his tissues. These dissolved gases must be removed by his circulatory and respiratory system during his ascent to the surface in a manner which precludes the formation of a clinically significant gas phase. This program evaluates in human decompression experiments the theoretical ascent profiles that have been developed for this purpose by proprietary computer methods. A five-lock, 700-cu.ft. pressure chamber system is being utilized for this investigation. This manned diving research facility is extensively instrumented for physiological research, its individual components provide working pressure equivalent to seawater depths ranging from 600 to 1000 feet.

Proprietary decompression schedules for helium-oxygen dives to up to 450 feet of seawater developed by this program have been extensively field-tested by Ocean Systems Operations, yielding a current level of incidence of decompression sickness of 2%. The current objective of this program is to extend this decompression capability to manned working dives to depths of 1000 feet.

SUPPORTED BY Ocean Systems Incorporated

6.0097, HUMAN PERFORMANCE

H.R. SCHREINER, Ocean Systems Incorporated, *Tonawanda, New York* 14150

The limits of human performance under conditions of submergence and exposure to high gaseous pressures is being investigated under this program. Particular attention is being directed to measuring the ability of the deep sea diver to perform manual and mental tasks and to determine the degree of deterioration of his performance under the influence of environmental factors.

SUPPORTED BY Ocean Systems Incorporated

6.0098, DECOMPRESSION TABLE DEVELOPMENT

H.R. SCHREINER, Ocean Systems Incorporated, *Tonawanda, New York* 14150

Using advanced mathematical models of inert gas transport in the human body this proprietary project is devoted to the: (1) computer analysis of past diving experience, (2) establishment by statistical methods of the probable risk of decompression sickness associated with any given dive profile, (3) development, by digital computer methods, of decompression tables for dives to depths of up to 1500 feet of seawater.

SUPPORTED BY Ocean Systems Incorporated

6.0099, NITROGEN-OXYGEN DECOMPRESSION TABLES FOR ALTITUDE FLIGHT

H.R. SCHREINER, Ocean Systems Incorporated, *Tonawanda, New York* 14150

The objective of this program is to complete the development of nitrogen-oxygen decompression tables for the safe ascent of aerospace personnel from gound level to altitude which was initiated during the first year of this contract. This will be done by (1) analyzing a total of 1388 altitude decompression histories accumulated under controlled laboratory conditions, (2) extracting from these computer- analyzed decompression histories statistically secured maximum permissible values of tissue nitrogen tensions in the ascent-limiting gas exchange compartment of the human body, and by (3) constructing with this information decompression tables for various ascent modes and nitrogen-oxygen compositions associated with extended manned spaceflights.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

6.0100, RESEARCH STUDIES IN MOLECULAR PHARMACOLOGY

H.R. SCHREINER, Ocean Systems Incorporated, *Tonawanda, New York* 14150 (PH-43-68-992)

Research under this program is designed to produce answers to the following two questions: (1) Do gases having important roles in pharmacology, anesthesia, and diving physiology alter the function of macromolecules by virtue of specific interactions? (2) What effects do these gases have on the permeability of cell membranes to amino acids, sugars and ions?

Approaches to be utilized in the execution of this program include the measurement of (1) solution and solid state binding equilibria of inert gases with biopolymers, (2) electronic absorption spectra of inert gas-model compound systems to determine possible charge-transfer interactions, (3) 'inhibitor' binding energies from thermodynamic analysis of enzyme inhibition kinetic data, and (4) membrane transport in cultured mammalian cells.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6C. MARINE TOXINS-PHARMACEUTICALS

6.0101, VENOMOUS FISHES AND SEA SNAKES OF SOUTHEAST ASIA

B.W. HALSTEAD, World Life Research Institute, *Colton, California* (N00014-67-C-0379)

The investigator and his associates propose to determine the identity and incidence of the venomous fishes and sea snakes in certain localities in Southeast Asia, investigate the morphology of the venom apparatus and the behavior related to aggression and the delivery of the toxins to the victims. Photographic records of the animals, as well as habitats, will be taken in the ecological phase of this project.

Less than a dozen of species of venomous fishes have been studied by venom experts and virtually nothing is known about the anatomy of the venom apparatus, the ecology of the populations of these forms or the factors which attract or induce aggression in these animals. The greatest concentration of the most dangerous of venomous fishes and sea snakes are found in Southeast Asia. It is essential that more be learned about these animals for the morale, as well as for the protection of personnel.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0102, CHARACTERIZATION AND MODE OF ACTION OF PROTEIN VENOMS OF MARINE ANIMALS

G.A. FEIGEN, Stanford University, School of Medicine, *Palo Alto - Stanford, California* 94305

During the past year Dr. Feigen has undertaken a preliminary investigation of the chemistry and mode of action of the venom produced by the Hawaiian sea urchin. The results of these studies show that the venom is a protein having a Svedberg coefficient of 2.6, that it is relatively stable at room temperature at a neutral pH, and that it precipitates from aqueous solution in the presence of 65%-saturated ammonium sulfate. It is lethal on intravenous and intraperitoneal injection in mice. It contracts the isolated guinea pig gut and produces arrest of the isolated guinea pig heart. Concomitantly, it liberates histamine from these tissues together with other physiologically active materials which have not yet been identified. Preliminary studies of its mode of action suggest that it may be a lecithinase.

The aim of the present research is to complete the chemical and pharmacological characterization of this venom and to initiate certain immunological, physiological, and biochemical studies to round out the understanding of its chemistry and mode of action. At the same time, it is intended to compare the chemical, pharmacological, and immunological characteristics of the venom of the Hawaiian species with that found on the Pacific Coast, particularly in the vicinity of the Hopkins Marine Station at Pacific Grove.

SUPPORTED BY U.S. National Science Foundation

6.0103, MODE OF ACTION OF MARINE TOXINS

G.A. FEIGEN, Stanford University, School of Medicine, *Palo Alto - Stanford, California* 94305

Studies during the current grant period have shown that crude sea urchin toxin contains a variety of enzymes which can react with serum proteins to form dialyzable physiologically active products that have striking pharmacological similarities to plasma kinins. Partially purified fractions have shown a high degree of substrate specificity, particularly with respect to attack on 1) purified a2-macroglobulin and 2) B-globulin. They also possess the property of inactivating the product as well as synthetic bradykinin. These fractions are immunogenic and the rabbit antibodies have been shown to 1) fix complement; 2) precipitate; 3) protect against, and 4) neutralize the toxin. This year our aims will be: 1) to continue purification by column chromatography; 2) to study the mode of enzymatic action on natural and synthetic substrates; 3) to determine the antigenic components; 4) and to attempt a characterization of the product formed by pharmacological and chemical methods, which will require the preparation of large quantities of material by the attack of the various enzymes on human plasma proteins.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0104, PHARMACOLOGY AND CHEMISTRY OF TOXIC MARINE ANIMALS

F.A. FUHRMAN, Stanford University, School of Medicine, *Palo Alto - Stanford, California* 94305 (N00014-67-C-0319)

Objective: Understanding the sources as well as the effects of toxins found in certain marine organisms is germane to successful survival techniques. Hence, it is important to have a background of pharmacological information regarding such toxins as those found in the eggs of certain fish.

Approach: The investigator will study the effects of cabezon (Scorpaenichthys marmoratus) toxin on lymphocytes in the blood, muscle contractions, and upon other organs. Preliminary studies of the chemical structure of the toxin and its purification have been necessary to provide material for the pharmacological studies.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0105, CHEMISTRY AND PHARMACOLOGY OF TETRODOTOXIN

H.S. MOSHER, Stanford University, Graduate School, *Palo Alto - Stanford, California* 94305

The distribution of tetrodotoxin in nature is being explored and a search is being made for other animal toxins.

Chemical studies aimed at the synthesis of tetrodotoxin-like structures are under investigation. The ultimate aim is to prepare related derivatives or analogs for further investigation of their pharmacological activity.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0106, USEFUL BIOMEDICAL MATERIALS DERIVED FROM THE SEA - AN INTERDISCIPLINARY APPROACH

J.H. GREEN, New England Inst. Med. Res. , *Ridgefield, Connecticut* 06877

Recent work identified the presence of a substance extracted from the liver of the lemon shark which acts as a stimulant to the body's host defense system and also suggested that other fractions of this same extract could inhibit this same system. At the present time physical and chemical analyses are being made to determine the structure of the active agents. Work under this project will include the determination of the scope and level of effectiveness of the materials in various disease states and the tolerance level and toxicity, if any. Also, efforts to understand the biochemical mechanism by which these materials activate the host defense system will be made.

The second phase of this project involves studies of bioluminescent marine planktonic organisms. While earlier work has identified the luciferin-luciferase system, the mechanism by which light is emitted is not completely understood. This program will attempt to further elucidate the system, especially to establish the nature of the light- emitting moiety. Secondly, the development of a method of growing bacteria will be completed; extraction and purification of the enzyme will be made to be completed; extraction and purification of the enzyme from Photobacterium fischeri on a preparative scale will be undertaken, and an effort will be made to find a linking system that will enable the bacterial luciferase to be used for detection of adenosine triphosphate and other co-factors which supplant firefly luciferase in these reactions.

SUPPORTED BY U.S. National Science Foundation

6.0107, PHYSALIA TOXIN AND THE ACTIVITY OF BIOLOGICAL MEMBRANES

C.E. LANE, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124 (N00014-67-A-0201-0003)

The investigator is examining the properties of the toxin of Physalia, the 'Portuguese Man O' War' which account for its activity on specialized conduction systems as those in the mammalian heart, on ionic regulation in crustaceans and on the sodium, potassium and ATP enzymes of gills, nerves and gut membranes of crustaceans. He is utilizing his knowledge of this toxin as a means to study the mechanisms of active transport in a variety of biological membranes.

Physalia, as well as most other pelagic coelenterates, produce a potent toxin. While some forms are mainly a nuisance, others are fatal and have been known to cause death in seconds. Its mode of action is not known and the proposed research may provide information useful in the development of antidotes for the slower acting forms or perhaps preventatives to be administered to personnel liable to encounter jellyfish. Knowledge about active transport through biological membranes is applicable to an enormous number of biological and medical problems.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0108, EFFECTS OF INGESTION OF RADIOACTIVE FISH AND THE NATURE AND BIOLOGY OF TOXINS IN CERTAIN FISHES

A.H. BANNER, Univ. of Hawaii, Hawaii Inst. of Marine Biology, *Honolulu, Hawaii* 96822

This is part of a comprehensive investigation of the toxin causing ciguatera, a disease resulting from the ingestion of coral reef fish in the tropical Pacific. Studies included in the project are: 1. An investigation of the biological origin and transmission of the toxin: it is suspected that the toxin originates in some alga at the base of the food pyramid and is transmitted through the food chain to the large carnivores where it is stored. 2. An investigation of the chemical nature of the toxin; the empirical and structural formula of the toxin, previously isolated at the ratio of approximately one part per million of raw fish, are currently being studied. 3. An investigation of the pharmacological action of the toxin; during the previous year it was established that this toxin is an irreversible anticholinesterase, and presently this knowledge is being utilized to develop a new in vitro assay, while other species of fish, previously considered to have the same toxin, are being investigated to determine the presence of a toxin with this specific action.

SUPPORTED BY U.S. Atomic Energy Commission

6.0109, EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC

A.H. BANNER, Univ. of Hawaii, Hawaii Inst. of Marine Biology, *Honolulu, Hawaii* 96822

The investigator and his team will search the waters near the tropical Pacific Islands for organisms in the food chain which may be the source or one of the sources of the toxins found in marine life, capable of causing severe poisoning in humans. Special attention will be accorded those organisms or toxins which have not been studied extensively.

The importance of understanding the geographical distribution and physiological action of toxins relates to protection of personnel which may consume toxic food under survival or recreational conditions and to the utilization of the substances for medical purposes may provide new investigation techniques in human pathology.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0110, EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC

A.H. BANNER, Univ. of Hawaii, Hawaii Inst. of Marine Biology, *Honolulu, Hawaii* 96822 (N00014-67-C-0127)

The investigator and his team are searching the waters off of the tropical Pacific Islands for organisms in the food chain which may be the source or one of the sources of the toxins found in marine life, capable of causing severe poisoning in humans. Special attention is being accorded those organisms or toxins which have not previously been extensively studied.

The importance of understanding the geographical distribution and physiological action of toxins relates to protection of personnel which may consume toxic foods under survival or recreational conditions. The utilization of these toxic substances for medical purposes may provide new investigative techniques in human pathology.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0111, PHYTOCHEMISTRY OF NARCOTIC PRINCIPLES IN CAULERPA.

M.S. DOTY, Univ. of Hawaii, Graduate School, *Honolulu, Hawaii* 96822

Three kinds of substances have been obtained in pure form: sterols, red crystalline caulerpin and a physiologically active compound, caulerpicin. Significant progress has been made toward processing 76 kilos of Caulerpa lamourouxii for major and pharmacologically active constituents. Techniques were developed and modified. Three papers were presentred in International Congress invitational symposia, one was published and two are in the manuscript stage.

Taxonomic studies preliminary to phytochemical work have been done on the genera Caulerpa and Laurencia.

Using special gas chromatographic columns, a mixture of about 50 aromatic substances has been obtained from Dictyopteris plagiogramma and D. australis and these are awaiting mass spectrometric determination.

At present the chemical work involves developing thin-layer chromatographic and other microassay methods for use in following the active substances in the food chain and in ecological work.

A marine laboratory has been refurbished and air conditioned for experimental culture of Caulerpa, and general culture methodology is being developed for future chemical biogenetic work.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0112, PACIFIC BIOMEDICAL RESEARCH

T.A. ROGERS, Univ. of Hawaii, Pacific Biomedical Res. Center, *Honolulu, Hawaii* 96822

Planning in the Pacific Biomedical Research Center will be continued with particular emphasis on development of: a) A Marine Experimental Laboratory for the exploitation of marine organisms for basic biomedical research. b) A research program in the pharmacology of natural products of the Pacific. c) A research program in regeneration of nerve structure and function. d) A program in Tropical Medicine, with initial emphasis on Hansen's Disease. e) A program in experimental psychiatry. f) Planning for the orderly development of rapidly expanding animal facilities in several physical locations.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0113, MARINE TOXINS OF THE TROPICAL PACIFIC

A.H. BANNER, Univ. of Hawaii, Hawaii Inst. of Marine Biology, *Kaneohe, Hawaii* 96744

6. PUBLIC HEALTH AND SAFETY

In the investigation all marine toxins arising from the tropical biota of the reef and shore fauna of the Central Pacific that may be passed on to man, directly or indirectly, will be studied. The studies are divided into three major phases: the biological origin, the chemical isolation and identification, and the pharmacological action of the toxins. Correlated with the major aspects of the investigation is the accumulation of local island knowledge of toxic marine animals, native remedies, and the epidemiology of fish poisoning in the Pacific.

For the present year of investigation, as in the previous years, the main emphasis will be upon those fish which are regionally toxic and cause the loosely defined disease known as ciguatera: biological field studies will be conducted in French Polynesia; chemical studies will attempt to further elucidate the structure of the toxic molecule, now isolated; and pharmacological studies will be concerned both with the development of assay methods adaptable for field conditions and with investigations of the mode and site of action of the drug.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0114, STUDIES ON VIBRIO FOOD POISONING

K. FUJIWARA, Chiba University, *Chiba City, Japan*

The purpose of this work is elucidation of manifestation mechanism in vibrio food poisoning. The project consists of two parts mainly.

The first one is feeding experiments with monkeys to examine synergetic activities of toxic metabolites produced by the pathogenic bacteria in provoking symptoms. The materials given will be mixtures of endotoxin fractions and haemolytic agents extracted from cells and culture supernatants of Fibrio parahaemolyticus. The materials of necropsy will be examined histologically and microbiologically.

The second part is study on host side factors in developing of food poisoning symptoms. In order to investigate the influences of substances in pharmacological activities similar to histamine i.e. serotonin will be given to experimental animals with living cells of Vibrio parahaemolyticus. And besides, the relationship between attack rate and situations of living, i.e. fatigue and other factors which might have influences on vegetative nervous systems, in human beings, will be investigated epidemiologicaly in many outbreaks of this type of food poisoning.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0115, ORGANIC CHEMICAL STUDIES ON ANIMAL AND PLANT TOXIN

Y. HIRATA, Nagoya University, *Nagoya, Japan*

Organic chemical studies are currently in progress on the following toxic components of plant and animal origins.

The main purpose of the present studies is correlation of chemical structure with physiological action, prevention of injuries due to poisoning and production of derivatives as potential medicines. 1) Alkaloids of Daphniphyllum macropodum M.: Structure proof of three crystalline compounds is being conducted. Transformation of yuzurimine to daphniphylline is being attempted. Physiological action of each alkaloid is being tested. 2) Alkaloids of Orchidaceae: Synthetic work is in progress. Structural investigations of newly isolated alkaloids is being conducted. 3) Alkaloids of Anodendron affine D. and of Trochelospermum asiaticum N. (Apocynaceae): The alkaloidal components have not as yet been obtained in a pure form. The latter one was reported to have anti-cancer properties. 4) Toxic plankton (Gonyaulax polyedra): We have collected a large amount of the plankton and are currently attempting purification of the toxic component(s).

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0116, MARINE ANIMAL TOXINS

S.L. FRIESS, U.S. Navy, Medical Research Inst. , *Washington - Bethesda, Maryland*

This effort is comprised of two closely related parts. The pharmacology and physiological pathways of biologically active substances from marine organisms and the modes of action of some of these substances when used in the field to repel or deter sharks. Holothurin, an extremely toxic substance produced by certain echinoderms is the primary subject of these studies. Other substances are also being sought which will have similar characteristics and action.

The need to become knowledgeable about biologically active substances from the sea is serious from several points of view. Very little is known about these substances, many of which are very different from terrestrial toxins. Personnel in survival, operational or recreational situations must be warned of the presence and behavior of dangerous local animals, antidotes, and treatment techniques must be developed. Since the producers of the toxins appear to use them against enemies, they serve as a likely source of information about protective chemicals and repellents, especially against sharks.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0117, ACTIVE CHEMICAL PRINCIPLES DERIVED FROM ECHINODERMS

S.L. PRIESS, U.S. Navy, Medical Research Inst. , *Washington - Bethesda, Maryland* (PO)

This work unit involves the study of the neuropharmacologic, enzymatic, and toxicologic properties of biologically active principles elaborated by marine animals and plants. Primary emphasis is directed to those natural products and their derivatives which exert blocking actions in mammalian neuromuscular tissures, or which appear to exert specific actions at chemoreceptor systems controlling behavioral responses to stimuli. Holothurin A, an extremely toxic substance extracted from the Bahamian Sea cucumber is the primary subject of these studies, while other toxins extracted from related Echinoderms are being compared pharmacologically.

Operational difficulties created by noxious marine animals point to the need to become knowledgeable about biologically active substances from the sea. Very little is known about the substances, many of which are very different from terrestrial toxins. Personnel in survival, operational, or recreational situations must be warned of the presence and behavior of dangerous local animals, antidotes, and treatment techniques must be developed. Since the producers of the toxins appear to use them against enemies they serve as a likely source of information about protective chemicals and repellents, especially against sharks.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0118, ELASMOBRANCH PHARMACOLOGY

S.L. SCHWARTZ, U.S. Navy, Medical Research Inst. , *Washington - Bethesda, Maryland* (PO)

This research program is a pharmacological survey of the elasmobranchs. Primary emphasis is on the actions of drugs and the consequences of their various means of administration on sharks. A comprehensive array of drug depressants and stimulants is being evaluated for their effects on the central, autonomic, and peripheral somatic nervous ysstems of sharks, as well as the cardio-vascular complex. Concurrently, the drug and stress-induced reactions of the study animals will be described as a function of the variation in their biochemical profile.

There exists a continuing need for knowledge of the many noxious marine animals encountered in Naval operations. Particularly important in this regard is the requirement for wide ranging studies on shark biology. Protection of Naval personnel from predacious shark activities and the related search for an improved shark repellent necessitate comprehensive data on the reactions of these animals to chemical and physical stimuli. Additionally, the increasing numbers of scientists who are utilizing sharks as study animals in Naval medical research relating to normal and abnormal human physiology and biochemistry point up the need for foundation studies such as this one.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0119, ELASMOBRANCH PHARMACOLOGY

S.L. SCHWARTZ, U.S. Navy, Medical Research Inst. , *Washington - Bethesda, Maryland*

This research program is a pharmacological survey of the elasmobranchs. Primary emphasis will be on the actions of drugs and the consequences of their various means of administration on sharks. A comprehensive array of drug depressants and stimulants will be evaluated for their effects on the central, autonomic, and peripheral somatic nervous systems in sharks, as well as the cardio-vascular complex. Concurrently, the drug and stress -induced reactions of the study animal will be described as a function of the variation in their biochemical profile.

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SUPPORTED BY U.S. Dept. of Defense - Navy

6.0120, MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES

R. REINERT, U.S. Dept. of Interior, Biological Laboratory, *Ann Arbor, Michigan*

A monitoring program to measure levels of insecticides in various species of fishes and water from each of the five Great Lakes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0121, COMPARATIVE STUDIES OF DINOFLAGELLATE TOXINS

J.J. SASNER, Univ. of New Hampshire, Graduate School, *Durham, New Hampshire* 03824

The proposed research program will attempt to elucidate the physiological and pharmacological effects of several naturally occuring marine dinoflagellate biotoxins. Primary objectives are; 1) to culture several toxin producing dinoflagellate species in the laboratory; 2) to concentrate these cells, extract and [illegible] the harmful materials; and 3) to test, in a comparative manner, their effects on living systems, particularly nervous and muscle tissues. The primary goal is to study the deleterious effects of these microorganism products on the electrogenic properties of excitable systems; including resting and action potential in nerve and muscle and parameters of contraction and tension development in muscle. Both vertebrate and invertebrate nerve-muscle systems will be tested. Similar experiments, comparing neurogenic and myogenic cardiac systems, are planned. In general, comparative studies will include the testing of toxins on invertebrate organisms, particularly Molluscs and Crustaceans which, in nature, are subject to the effects of dinoflagellate 'blooms'.

The association of paralytic shellfish poisoning and ciguatera- like poisoning with substances produced by marine dinoflagellates has closely linked commercial fisheries research with that of public health Relatively recent chemical and biological findings concerning this association will now permit studies of the comparative effects of these naturally occuring biotoxins, as well as their specific site(s) and mode(s) of action. It is toward this understanding that this research proposal is intended.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0122, STUDIES ON PHARMACOLOGICALLY ACTIVE COMPOUNDS DERIVED FROM MARINE ORGANISMS

R.F. NIGRELLI, New York Zoological Society, *New York, New York*

Chemical and pharmacological characterization of antibacterial, anti-viral, antitumorous, nerve-blocking and other metabolic regulating substances derived from marine organisms.

SUPPORTED BY John A. Hartford Foundation Incorporated

6.0123, NEW DRUGS FROM THE SEA, ESPECIALLY ANTIBIOTICS

P.R. BURKHOLDER, Columbia University, Graduate School, *Palisades, New York* 10964

Numerous kinds of marine plants and animals are being screened for antimicrobial properties and other kinds of biological activity. Crystalline compounds and oils have been isolated from marine algae and sponges and the chemical structures determined for some of them.

Research will continue mainly on the isolation and characterization of antimicrobial substances produced by marine flora and fauna in the Caribbean Sea and in the Pacific Ocean.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0124, STUDY OF TOXIN SYNTHESIS IN PRYMNESIUM PARVUM

G.M. PADILLA, Duke University, School of Medicine, *Durham, North Carolina* 27706

To establish axenic cultures of marine and fresh water algae that yield toxins of potential health hazard in order to study the factors which govern the growth and toxigenesis of such organisms. To continue investigations on the cellular localization of toxin synthesis in the euryhaline flagellate Prymnesium parvum by density gradient ultracentrifugation and extend such studies to representatives of dinoflagellates, such as Gonyaulax and Gymnodinium. Lastly, to develop physiological and chemical assays of such toxins to determine their mode of action, chemical identity, and potential use as pharmacological agents.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0125, UTILIZATION AND PREPARATION OF FISH PROTEIN CONCENTRATE

J.E. LANGLER, Oregon State University, Agricultural Experiment Sta. , *Corvallis, Oregon* 97331

Objectives: (1) To develop nutritive fish protein concentrates suitable for use in human diets, (2) To nutritionally evaluate fish protein concentrate, (3) To investigate the basic chemistry of fish protein concentrates. (4) To investigate, develop and/or improve products utilizing fish protein concentrate that are aesthetically consistent and of acceptable flavor to the ethnic and national groups intending to use fish protein concentrate in their diets. A fish protein concentrate (FPC) will be developed that is suitable for use in human diets. Experiments will be conducted to evaluate and expand basic knowledge concerning the chemistry and nutritive value of FPC. New and/or existing products will be investigated utilizing FPC as a source of protein. Especially efforts will be directed toward the development of food products that will be acceptable to those in the developing nations who are desperately in need of nutritive proteins in their diets.

SUPPORTED BY Oregon State Government

6.0126, MARINE ANIMAL USE IN THE STUDY OF HEALTH PROBLEMS

I. PRATT, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

The proposed work is subdivided into 3 parts:

Ivan Pratt will work on the life cycle of a hemiurid trematode, Tubulovesicula lindbergi and start or continue several other trematode and acanthocephalan ecology studies.

Austin Pritchard will study the metabolism of intertidal molluscs and crustacea by varying oxygen tension, temperature and other ecological factors.

Frederick Hisaw, Jr. will work on the isolation and effects of various hormones or hormone-like substances found in fish, tunicates and echinoderms.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0127, CONTROL OF PLANT PATHOGENS USING ACTIVE ANTIMICROBIAL SUBSTANCES ISOLATED FROM MARINE ALGAE

N.G. NADAL, Univ. of Puerto Rico, Agricultural Experiment Sta. , *San Juan - Rio Piedras, Puerto Rico* 00931

Description of Work: Sarganin complex purified from crude extracts of Sargassum natans, Chondria littoralis, Cymopolia barbata will be separated in A and B fractions by paper chromatography. Their effect (using bioautographs) will be studied on such plant pathogens as Fusarium of tobacco and coffee, Cercospora of tobacco, coffee and banana, Alternaria of tobacco and Pseudomonas on tomatoes. Dose response curves will be drawn. Synthetic and natural medias (plant tissue extracts) will be evaluated as well as the effect of nutrition on pathogenicity of the organisms. Evaluation will be made using antiobiotics (cyclohemide, antimycin and streptomycin) as control standards.

SUPPORTED BY Puerto Rico Government

6.0128, ACTIONS OF BIO-TOXINS ON CELL MEMBRANES

M.H. EVANS, Agric. Research Council, *Cambridge, United Kingdom*

It is proposed to determine, as a first stage, how many so-called 'neurotoxins' of animal origin (snake and other venoms, tissues of poisonous animals and toxins produced by marine organisms) have specific actions upon the nervous and muscular systems of higher vertebrates. If modern meurophysiological research techniques confirm that a poison has a specific neurotoxic action, then that poison will be subjected to a more detailed analysis to try and determine the site and mode of action, in the hope that some of these poisons may prove to be useful tools for the physiological research, or may have valuable therapeutic applications.

Some progress in this direction has already been made in the case of some relatively simple stable substances such as Tetrodotoxin and Saxitoxinn. As these two poisons are now available in pure form it is proposed to subject their actions on nerve and muscle cell membranes to further detailed electrophysical analysis.

Concurrently, the more complex protein types of toxin, especially the venoms of some snakes (Crotalus, Naja and Notechis species) scorpions (Androctonus, Buthus and Centruroides spp.) and spiders (Atrax and Latrodectus spp.) will be studied with the intention of determining whether their reported neurotoxic actions are due primarily to some specific toxic constituent or are more general consequences of their enzymatic activity.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6D. SAFETY AT SEA

(navigation Safety; Shark Attacks.)

6.0129, SURVIVAL CRAFT DRIFT AND LEEWAY

R.C. CLASBY, U.S. Dept. of Transportation, Oceanographic Unit, *Washington, District of Columbia*

This project is an attempt to determine the effects of wind and sea surface currents on various types of survival craft. The data will be used to update the drift and leeway tables presented in the National Search and Rescue Manual (CG-308).

The project was initiated in FY-68 and will be a continuing project at this Unit.

During the studies buoy-surface current meter systems, with a wind recorder, will be implanted. An 'over-the-side' deck recording current meter will be used, and surface drogues tracked. Various types of life rafts will be used. No oceanographic casts will be made during any of the cruises.

This project is designed to provide a controlled experiment from which data concerning the direct effects of surface currents and wind on various types of survival and small craft can be obtained. This data can then be used to up-date the drift and leeway tables in the Coast Guard Search and Rescue Manual resulting in an increase in search accuracy. The tables now used were prepared during the late 1940's and are very general in scope, having been based on observations with small life rafts at low wind velocities.

Surface currents will be determined from a stationary buoyed current meter and surface drogues. Surface winds will be determined from a wind recording system also mounted on the buoy. The test craft will be equipped with radar transponders and radar reflectors to facilitate tracking. Positions of underway targets will be referenced to two stationary radar targets, i.e. Nantucket Light Vessel and the instrumentation buoy.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

6.0130, SEARCH AND RESCUE - U.S. COAST GUARD

A.E. KARP, U.S. Dept. of Transportation, Coast Guard, *Washington, District of Columbia* 20591

The objective of this project is to provide consultants to assist with problems concerned with locating and rescuing victims of marine accidents. These services will include definition of Operations Research Studies and aid in monitoring such studies.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

6.0131, DIVER NAVIGATION DEVICE

F.J. ROMANO, U.S. Navy, Ship Systems Command, *Washington, District of Columbia* 20360

Objective: Provide an accurate means of navigation for the individual diver. Swimmer missions require precise navigation. Insure location of the objective in restricted visibility water.

Equipment fulfilling this need must be extremely compact, neutrally buoyant and easily handled by a swimmer and yet provide reliable navigation data regardless of adverse conditions. The system or systems must withstand the environmental conditions imposed.

Approach: Through industry or Navy labs a model of an active self-contained navigation device will be constructed to demonstrate feasibility applied to individual swimmer navigation. This system will include a total depth recorder for bottom profile mapping, and thus provide a complete device specially suited for the navigation problem in the inshore area. The device will present and record course, drift angle and distance traveled information to the swimmer plus providing a permanent record of total water depth.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0132, STUDIES OF SHARK REPELLENTS AND OTHER ANTI-SHARK MEASURES

H.D. BALDRIDGE, U.S. Navy, Aerospace Medical Center, *Pensacola, Florida* 32512

The purpose of this project is the development of reliable assay procedures for determining shark repellent activity with a low dependency on subjective observations. Supportive field and laboratory research is being carried out in the areas of buoyancy-maneuverability and drug exposure dynamics as physical and chemical factors affecting shark behavior.

One section of the Noxious Marine Animal Program is concerned with the biology of sharks. Sharks pose a physical, as well as psychological, hazard to personnel in the sea for operational or recreational purposes. They may also cause the loss of moored and floating equipment because they are capable of biting through cable and puncturing flotation gear. In order to develop effective shark repellents and survival techniques, therefore, it is necessary to determine the dynamics, mode, and limits of action of physico-chemical factors in the natural or induced field environment which influence these animals.

SUPPORTED BY U.S. Dept. of Defense - Navy

6E. WATER QUALITY AND POLLUTION

(waste Disposal Effects; Pollution Identification, Monitoring, andMovement. See Chapter 5 For Effects on Non-humans and Chapter 8m ForEngineering Aspects.)

6.0133, FATE OF INLAND DERIVED POLLUTANTS IN AN ESTUARY

R.B. MEDZ, Univ. of Alaska, U.S.D.I. Alaska Water Lab. , *College, Alaska* 99735

Organics and inorganics in an estuary have both marine and ground and surface water resources. The changes occurring to inland originating organic and inorganic pollutants as they enter the estuarine environment and the determination of their impact on the biota of the estuary will be investigated. The overall objective is to isolate sources of pollutants that have an unfavorable effect upon the estuarine environment and through a systems analysis to determine how these pollutants can most effectively be removed from the water system.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0134, RELATIONSHIP BETWEEN GLACIAL FLOUR POLLUTION AND POLLUTANTS FROM OTHER SOURCES

D.L. WORF, Univ. of Alaska, U.S.D.I. Alaska Water Lab. , *College, Alaska* 99735

In the heavily glaciated areas of Southeast Alaska glacial silt is washed into the estuaries in large amounts. Industrial wastes from the paper pulp and canning industries and domestic and marina sewage could interact as floatation and foaming agents with this finely divided silt. The nature of this interaction, the suceptibility of the adsorbed organic pollutants to stabilization by the estuarine biota, the effect of this pollution floated silt on the estuarine biota, and the ability of the silt to coagulate and settle with adsorbed pollutants will be studied and methods will be developed to prevent glacial flour-organic pollutant interactions that have been shown to be unfavarable.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0135, HISTORICAL STUDY ON EFFECT OF HARBOR DREDGING ON THE ENVIRONMENT (ENVIRONMENTAL FACTORS PERTINENT TO EFFECTS ON MARINE ENVIRONMENTS)

M.J. CRUICKSHANK, U.S. Dept. of Interior, Marine Min. Technol. Ctr. , *Belvedere - Tiburon, California* 94920

The methods used in mining a marine mineral deposit will have an effect on the efficiency of mining and also on the surrounding environment. The nature of the excavation, the disposal of the barren material, and the general disturbance of the area, will each present its own problems.

Such problems must be studied from the point of view of the exploiter and of the conservationist.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

6.0136, SAN PABLO BAY STUDY

F.A. NUDI, U.S. Dept. of Interior, Tiburon Marine Lab. , *Belvedere - Tiburon, California* 94920

Objectives: To determine the effects on marine life caused by increased dredging and spoil disposal by the Army Corps of Engineers at pre-selected areas in San Pablo Bay in cooperation with U.S.B.S.F.W. River Basins.

Procedure: Monthly sampling will be made for the collection of water samples and marine organisms at five separate areas involving twelve station from Tiburen Peninsula to Carquinez Strait. Sampling areas include past, present and future dredged and spoiled areas as well as areas yet undisturbed. The type of sampling to be done will include trawling with a 15-foot otter trawl to determine the abundance and distribution of benthic swimming animals, bottom samples taken with a Birge-Ekman dredge to determine the types and abundance of smaller, more sedentary benthonic animals and water samples taken at surface and off-bottom to measure the temperature, and dissolved oxygen present.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

6.0137, EDDY DIFFUSION AND BACTERIAL REDUCTION IN WASTE FIELDS

J.E. FOXWORTHY, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

The principal objectives of the proposed work are: 1. To further demonstrate the applicability of previously proposed continuous volume source diffusion models to the dispersion of conservative tracer dye and bacteria within surface waste fields in the sea. 2. To ascertain the effect of the type of submarine outfall on the rate of dispersion of tracer dye and bacteria. 3. To determine, under field conditions, the rates of disappearance of coliform and Fecal Streptococcal Group bacteria. 4. To investigate the effect of vertical mixing combined with radiant energy (sunlight) on bacterial disappearance in surface waste fields.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0138, ULTRAVIOLET ABSORPTION IN COASTAL WATERS

R.B. TIBBY, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

The proposed work revolves around the basic hypothesis that UV absorbance is a quantitative measure of the extent and dilution of a marine sewage field and that it is directly related to organic load and may be a better index to organic load than BOD.

Improved methods developed during the past year for determining dissolved, particulate and total carbon, and for separating the contributions of organic and inorganic constituents of the waste field and of the background waters, now will be applied in situ and in conjunction with the routine monitoring programs of selected waste disposal agencies in Southern California whose discharge is subject to primary, secondary, or tertiary treatment.

The procedures also may provide information on the rates of biodegredation in the marine environment.

Present studies on the productivity of phytoplankton and benthic algae by oxygen evolution and isotopic carbon uptake will be continued, and will be correlated with the release of extracellular metabolites as determined by UV absorbance.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0139, WATER QUALITY AND NUTRIENTS, SACRAMENTO-SAN JOAQUIN RIVER SYSTEM

W.D. SILVEY, U.S. Dept. of Interior, Water Resources Division, *Menlo Park, California*

This research is part of the program of water resources investigations conducted by the U.S. Geological Survey in cooperation with the State of California. The total project is to provide the knowledge needed to avoid excess blooms of tidal plankton and undesirable concentrations of dissolved oxygen by determining the relationships between nutrients, tidal plankton, dissolved oxygen, and fish in this estuarian environment. The water quality aspects of the study includes source and concentration of both organic and inorganic constituents in waters in the delta system together with pertinent physical characteristics.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

6.0140, EFFECTS OF WATER POLLUTION IN SAN FRANCISCO BAY

R.K. LINSLEY, Stanford University, School of Engineering, *Palo Alto - Stanford, California* 94305

1. To determine how people are affected by water pollution in San Francisco Bay. 2. To estimate the number of people affected in various ways by water pollution in the bay. 3. To measure attitudes toward water pollution in the Bay. 4. To determine where people acquire information about pollution in the Bay. 5. To determine what actions of adjustment (substitution, curtailment of activity, reduction in frequency of participation, etc.) are taken by people as a result of water pollution in the Bay. 6. To obtain data that could be used in an assessment of the econimic value of water pollution control measures, especially the value of recreational activities and esthetics.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0141, POLLUTION STUDY OF THE VENICE DISTRICT CANAL

W.A. ANIKOUCHINE, Oceanographic Services Inc. , *Santa Barbara, California* 93105

Study conducted in a 90-foot scaled hydraulic model of the canal.

SUPPORTED BY Los Angeles City Government - California
Koebig & Koebig, Inc.

6. PUBLIC HEALTH AND SAFETY

6.0142, EFFECTS OF HEATED WATER DISCHARGE ON THE MARINE ENVIRONMENT

D.D. POLLARD, Oceanographic Services Inc. , *Santa Barbara, California* 93105

00NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Redondo Beach City Government - California

6.0143, ORGANIC DEBRIS ON CONNECTICUT BEACHES AND SHORES

R. BENOIT, General Dynamics Corporation, *Groton, Connecticut*

General field surveys of selected sites are made. The quantity and identity of beach debris present in significant amounts is determined. Water characteristics (temperature, dissolved oxygen, salinity, turbidity) are determined. The origin of the debris is determined if possible. The microbial flora of water, sand, mud, and debris are determined in relation to the mode of decomposition of the debris.

SUPPORTED BY Connecticut State Government

6.0144, STUDY OF EFFECTS OF OFFSHORE DUMPING

T. SAVILLE, U.S. Army, Coastal Engin. Res. Center, *Washington, District of Columbia* 20016

Study will be made of the effects on the local environment of the offshore dumping (under Corps of Engineers permit) of such things as sewage sludge, cellar dirt, and acid wastes. Study will include circulation and dispersion patterns, and changes in bottom characteristics, and collection of bottom organisms. Data are planned for eventual interpretation in terms of effects on biota. Initial work will be done in the New York Bight.

SUPPORTED BY U.S. Dept. of Defense - Army

6.0145, EFFECTS OF HEATED WATER IN A TIDAL ESTUARY

R.L. CORY, U.S. Dept. of Interior, Water Resources Division, *Washington, District of Columbia*

The Patuxent River is one of the few rivers entering Chesapeake Bay that presently is more or less free from cultural influences. In the near future rapid change is expected to result from urbanization in the upper basin and operation of a large generating plant at Chalk Point, which will significantly alter the temperature of the water in that vicinity. At times the heated water released into the estuary will be equal to or greater than the fresh water inflow.

The objective of this project is to understand the effects of such release in the physical, chemical, and biological character of a tidal river by studying the yearly and seasonal attachment, rates of growth and mortality of attached organisms, and associated physical factors, including salinity. Interrelations between the environment and aquatic biota will be determined for the normal hydrologic condition and the heated condition over a period of about two years for each.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

6.0146, DEMONSTRATION OF THE LIMITATIONS AND EFFECTS OF WASTE DISPOSAL ON AN OCEAN SHELF

R.F. MCALLISTER, Florida Atlantic University, Graduate School, *Boca Raton, Florida*

The purpose of this project is to learn the existing ecological regimen of an area subject to waste injection, and the effect of waste injection on an ocean shelf through a combined oceanographic and biological survey. It is further intended to learn how, by knowledge of local currents, to optimize the location of sewage outfalls. Studies will include the analysis of water and bottom samples and classification of the fauna and flora.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl
Boca Raton City Government - Florida

6.0147, PESTICIDE MONITORING PROGRAM

P.A. BUTLER, U.S. Dept. of Interior, Biological Laboratory, *Sabine Island - Gulf Breeze, Florida*

Cooperative program involving 15 private, state and federal laboratories who collect duplicate samples of mollusks from approximately 175 estuarine stations on Atlantic, Gulf and Pacific coasts at monthly intervals. Program initiated 1965, proposed to continue until 1969; 1500 analyses completed September 1965. Samples are sent to the Gulf Breeze Laboratory for pesticide residue analysis. Eastern oyster is chief bioassay animal, also used Mya arenaria, Mercenaria mercenaria, Ostrea luria, Crassostrea gigas and some fish species. Each sample is screened for Aldrin, BHC, Dieldrin, DDD, DDE, DDT, Endrin, Heptachlor, Heptachlor epoxide, Lindane and Methoxychlor. Analyses are made wiith electron capture gas-liquid chromatography techniques.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0148, PESTICIDE KINETICS

C.W. MILLER, U.S. Dept. of Interior, Biological Laboratory, *Sabine Island - Gulf Breeze, Florida*

Investigate, under field conditions, the occurrence and distribution of insecticides in tidal areas associated with an estuary. Samples of water, soil and selected biota will be collected immediately prior to application of the test material to establish a base line indicative of previous commercial treatments. The persistence, localization and possible degradation of the test chemicals will be followed.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0149, CHEMICAL ANALYSES

A.J. WILSON, U.S. Dept. of Interior, Biological Laboratory, *Sabine Island - Gulf Breeze, Florida*

In order to evaluate data now being obtained by a nationwide surveillance of organochlorine pesticide pollution in estuaries, studies are in progress to determine rates of uptake and the metabolism of these pollutants in marine species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0150, BACTERIOLOGICAL STUDY OF THE POLLUTION OF KANEOHE BAY, OAHU

K.R. GUNDERSEN, Univ. of Hawaii, Water Resources Research Ctr. , *Honolulu, Hawaii* 96822

A comprehensive study of coliform distribution and other indicator bacteria of sewage oringin will be made of the water in Kaneohe Bay, Oahu, Hawaii including hydrological and meteorological observations.

Six sites near sewage outfalls and in the Bay will be sampled at two water depths and of the bottom deposit. Sewage just prior to disposal will also be sampled. All liquid samples will be collected at least weekly and with aseptic technique. Liquid bottom samples will be analyzed for coliforms 35 degrees C, thermostable 45 degrees C, enterococci 35 degrees C and total count 25 degrees C. Prior to sampling, air and water temperatures, wind direction and speed, cloudiness, rainfall, water turbidity will be measured.

This study is expected to provide the much needed data for determining the degree of sewage treatment required and for a planned study of the bacterial involvement in the transformations of inorganic nitrogen and sulfur compounds in the Bay.

Technological Objectives - The hydrogen ion activity (ph) is an important parameter in chemical and biological processes. Over the years a pH scale in water has been developed at the National Bureau of Standards augmented by a series of standard reference materials. As work is extended to other systems (deuterium oxide, sea water, non- aqueous solvents) a parallel activity scale and a series of standard

oceanography has made the development of a pH scale in sea water most pressing. The present work at NBS to define a pH scale in sea water and develop standard reference materials will fill the need in this area.

Approach - A 'standard' sea water for this work is being developed and a pH scale is being defined in this medium. Accompanying this is a study of the deviations in pH with changes in salinity. Once the
of defining standard reference materials.

SUPPORTED BY University of Hawaii
Hawaii State Government

6.0151, ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST

C. YEH, Univ. of Maine, Agricultural Experiment Sta. , *Orono, Maine* 04473

Objectives: 1) To determine the product flow and existing charactaristics of the commercial fishing industry and its relative importance in the Northeast, 2) To analyze the dynamic aspects of the supply and demand situation for the major species of finned fish and shellfish of the Northeast, and 3) To assess implication of potential changes in the market structure and its performance on the fishing industry, poultry and livestock producers and consumers.

Description: The Delaware station will concentrate primarily on studying menhaden and other fish used in animal feeds. The first procedural step will require the compilation of data related to the distribution of menhaden fish including the primary markets, marketing channels and product use by poultry and livestock.

Estimates of supply and demand parameters for menhaden fish will be obtained. Statistical procedures including linear programming and single equation regression models will be used to evaluate the relationship of fish meal to poultry and livestock production.

SUPPORTED BY U.S. Dept. of Agriculture
Delaware State Government

6.0152, EFFECTS OF THERMAL POLLUTION ON PRODUCTIVITY AND STABILITY OF ESTUARINE COMMUNITIES

J.A. MIHURSKY, Univ. of Maryland, Natural Resources Institute, *College Park, Maryland*

A multidisciplinary investigation is proposed to study thermal pollution of an estuarine community. Laboratory studies of behavioral, metabolic and growth responses to heat stress will be integrated with field experiments to evaluate the overall impact of thermal pollution on an estuarine ecosystem.

Specifically, the laboratory phase will study representative species from the phytoplankton and planktonic herbivores. Growth of algae and intrinsic rates of increase of copepod populations will be used to evaluate thermal stress separately and when other environmental components are varied. At the same time, survival, behavior and metabolism of vertebrates and macro-invertebrates will be measured in gradients of temperature and salinity.

Field experiments will determine the influence of heat pollution on several trophic levels. Rates of mortality, biomass turnover or production and energy flow will be used to evaluate the impact of pollution. An ideal field situation has been provided by the newly constructed electrical generating plant at Chalk Point on the Patuxent river estuary.

The field experiments may be divided into those which test the direct effect of the passage of a part of the estuary through the power plant. The indirect effect of effluent water on the planktonic community adjacent to the power plant may be determined by correlation and comparison with pre-existing patterns of biomass, production and species structure of the plankton. Similarly, pre-pollution-phase measurements of vertebrate and macro-invertebrate standing stocks may be correlated and compared with those existing under thermal pollution.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Maryland

6.0153, IMPACT AND FATE OF POLLUTION IN ESTUARIAL WATERS

C.F. COLE, Univ. of Massachusetts, School of Agriculture, *Amherst, Massachusetts* 01003

The project is a comprehensive, long-range study of Massachusetts estuaries to determine the origin, character, distribution, influence and fate of ionic, molecular, colloidal and suspended pollutants reaching the estuary and to examine ways in which natural tidal flushing action may be improved. The initial phase of this broad program involves the effects and ultimate fate of pesticides used for cranberry culture on land draining into the Weweantic estuary on the southern shore of Cape Cod. These studies are directed to the following: 1. Bio-degradability of selected pesticides. 2. Influence of pesticides and other environmental variables on the fish population of Weweantic estuary. 3. Adsorption of pesticides on representative soils and the ultimate fate of these adsorbed pesticides reaching the water resource on silt particles.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Massachusetts

6.0154, RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES

R. REINERT, U.S. Dept. of Interior, Biological Laboratory, *Ann Arbor, Michigan*

A program to follow the buildup of insecticides in lake trout and coho salmon that have recently been introduced into Lakes Michigan and Superior. The eggs and fry will be studied before the fishes are introduced into the lakes and then as these populations develop they will be sampled periodically. When the fishes reach maturity their eggs and progeny will be examined for insecticide levels.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0155, MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ORGANISMS

R. REINERT, U.S. Dept. of Interior, Biological Laboratory, *Ann Arbor, Michigan*

A laboratory program designed to compare the relative importance which direct uptake of insecticides from water and biological magnification via the food chain have on the buildup of chlorinated hydrocarbon insecticides in aquatic communities.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0156, COMPOSITION OF LEAD HALIDE POLLUTION AEROSOLS

J.W. WINCHESTER, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan*

It is proposed to determine the relative composition of aerosol particles over the range of radius 0.2 to 10 microns with respect to lead, chlorine, bromine, and iodine. In urban areas pollution sources are probably significant for all these elements, but in the natural atmosphere substantial amounts of chlorine, bromine, and iodine come from the sea. Sampling of atmospheric particles is done by means of a cascade impactor, and analysis for these elements is carried out using anodic stripping voltammetry for lead and neutron activation for the halogens. Initial results have indicated distinctive particle size distribution patterns for each of the four elements, and these patterns are interpreted in terms of the source of the particles and chemical reactions in the atmosphere involving oxidation, volatilization, and condensation. Sampling and analysis are planned to reveal the details of the interrelationships among these processes.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0157, GREAT LAKES RESEARCH - SPOIL DISPOSAL EFFECTS

A.P. PINSAK, U.S. Army, Lake Survey, *Detroit, Michigan* 48226

Physical, chemical and biological factors within the water mass and associated solid material which can be related to dredging and disposal of spoil material are being investigated in order to determine effects of this material on characteristics of the lakes. The study will examine changes in water characteristics, dispersion rates, and areal extent; changes in nature of bottom sediments from dumping and dredging and degree to which characteristics of these sediments are improved; and different effects of various dredging techniques on pollution.

Field investigations during 1967 centered on eleven selected rivers, harbors, and open water and diked disposal areas of different basic types in Lakes Erie, Huron, and Michigan. Inasmuch as data on actual levels of pollution which can be traced to various kinds of dredging is lacking, each area was studied before, during, and for a significant period after dredging and disposal of spoil material.

Interim reports for each study area are being prepared and a comprehensive report is scheduled for completion in 1968.

SUPPORTED BY U.S. Dept. of Defense - Army

6.0158, LAKE MICHIGAN CHEMICAL CONTROL OF SEA LAMPREY

W.E. GAYLORD, U.S. Dept. of Interior, Biological Station, *Lundington, Michigan*

The Bureau of Commercial Fisheries, under the direction of the Great Lakes Fishery Commission, is using selective larvicides as an experimental method of control for sea lampreys in Lake Michigan. The study is designed to eliminate all generations present in the streams tributary to the lake by treatment of these streams with chemical, and to determine if such action will control effectively the parasitism on lake trout and other fish.

The control method requires a thorough knowledge of: the presence and distribution of ammocete populations in tributaries; physical characteristics and flow data of infected streams, accurate bioassays and chemical analyses of the water; precise metering of the chemicals; and posttreatment surveys to measure and analyze the effectiveness of individual treatments.

A total of 99 Lake Michigan streams contain sea lampreys. All streams were treated by July 1966. Treatments since then have been repeated at approximately 4-year intervals or at intervals determined from observations on the rate of reestablishment and growth of sea lampreys.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0159, LAKE HURON CHEMICAL CONTROL

B.R. SMITH, U.S. Dept. of Interior, Biological Station, *Marquette, Michigan*

The Bureau of Commercial Fisheries, under the direction of the Great Lakes Fishery Commission, is using selective larvicides as an experimental method of control for sea lampreys in Lake Huron. The study is designed to eliminate all generations present in the streams tributary to the lake by treatment of these streams with chemical, and to determine if such action will control effectively the parasitism on lake trout and other fish.

The control method requires a thorough knowledge of; the presence and distribution of ammocete populations in tributaries; physical characteristics and flow data of infected streams, accurate bioassays and chemical analyses of the water; precise metering of the chemicals; and posttreatment surveys to measure and analyze the effectiveness of individual treatment.

There are 48 tributaries along the U. S. shore of Lake Huron known to contain sea lampreys. Three of these were treated in 1962. Treatments in this area were resumed in 1966 and 18 streams were treated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0160, A STUDY OF THE OPEN WATER DISTRIBUTION AND ABUNDANCE OF NET-PLANKTON AS AN INDEX OF EUTROPHICATION IN LAKE SUPERIOR

T.A. OLSON, Univ. of Minnesota, School of Public Health, *Minneapolis, Minnesota* 55455

This research is aimed at applying the Continuous Plankton Recorder Techniques of Hardy to non-oceanic situation, namely Lake Superior. Hardy recorders were designed for marine work and can be towed behind merchant vessels and other commercial craft proceeding at their normal cruising speeds. During these tows, a band of silk bolting cloth is automatically fed across a tunnel-opening to collect organisms from the water. Under highly efficient filtering conditions, three cubic meters or 3000 liters of water are strained over each ten-mile section of the course and organisms in the catch are deposited in a chronological order on the moving band. After exposure the band is covered by another layer of silk to hold the organisms in place and the two bands are then tightly rolled up in a small tank of formalin preservative. At the end of each 500-mile run the roll is removed from its chamber and shipped to the laboratory where a count is made of the organisms. The zooplankters (herbivores) which make up the second trophic level of the ecological pyramid can be accepted as a reflection of the primary production and therefore as an expression of the state of fertility or quality of the water being studied.

Because such large areas can be covered and each mile traversed can be associated with a definite point on the bolting cloth band one can detect variations which occur over the entire lake and can readily locate such areas of variance accurately on a geographical basis. The method is envisioned as a practical parameter of water quality which will be of distinct value in studies of any of the Great Lakes.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Minnesota

6.0161, BRACKISH WATER PURIFICATION BY BIOLOGICAL FUEL CELL POWERED ELECTRODIALYSIS

W.A. SCHELLER, Univ. of Nebraska, School of Engineering, *Lincoln, Nebraska* 68508

Purification of brackish water containing 1000-5000 ppm of salts by electrodialysis appears to be more economical than any of the present day distillation techniques, but it is still expensive. A reduction in the water costs might be realized if a useful byproduct were produced in the water purification process.

The primary objective of the proposed research is to investigate the possibility of using an electrodialysis cell for brackish water purification in conjunction with a biological fuel cell powered by microorganisms capable of living in the brine effluent from the electrodialysis unit, feeding on cellulose containing materials such as hay, corn stalks, etc. and suitable for processing into cattle feed or feed supplement. Furthermore it is planned to investigate the effect of operating variables on the performance of the electrodialysis unit within the range of voltage-current-power capabilities of a battery of biological fuel cells. Finally, using the experimental results as a basis, economic evaluations will be made in order to determine the economic optimum arrangement of electrodialysis units and biological fuel cells. This is a five year program from fiscal 1966 through fiscal 1970.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Nebraska

6.0162, MICROBIOLOGY OF ESTUARINE AND SHELLFISH POLLUTION

L.W. SLANETZ, Univ. of New Hampshire, Graduate School, *Durham, New Hampshire* 03824

The research objectives of this project are designed to (1) determine the reliability of current bacteriological criteria or standards for monitoring the sanitary quality of shellfish and shellfish growing waters, (2) determine whether fecal streptococci should replace coliforms as indicators of fecal contamination of estuarine water and shellfish, (3) determine whether bacteriophages will be useful indicators of enteric virus contamination of estuarine water and shellfish, (4) evaluate depuration procedures and factors which affect the decontamination of oysters and clams under laboratory and field conditions, (5) determine the efficiency of newly installed sewage treatment plants in reducing or eliminating contamination of estuarine waters with enteric bacteria and viruses.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0163, DELAWARE ESTUARY AND BAY WATER QUALITY SAMPLING AND MATHEMATICAL MODELING PROJECT

J.F. WRIGHT, Delaware River Basin Comm. , *Trenton, New Jersey*

The purpose of this project is to evaluate the accuracy and reliability of the research data, and information made available for use in a mathematical model of the Delaware Estuary by conducting a series of sampling runs in the estuary over a period of years. These samples will be analyzed and compared with mathematical model projections in an effort to validate the mathematical concept for use in an estuary pollution abatement program.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl
Delaware River Basin Commission

6.0164, RADIOACTIVE AEROSOL SCAVENGING BY OCEAN SPRAY

E. HARDY, U.S. Atomic Energy Commission, Operations Office, *New York, New York*

The possibility that more fallout occurs per unit area onto the ocean than onto land has encouraged speculation that the spray produced from breaking waves may be an effective scavenger of nuclear debris from the lower troposphere. Scavenging action of spray will be examined both in the laboratory and at sea, and the total amount of Sr-90 deposited into the North Atlantic Ocean due to spray action will be estimated. Attachment of radionuclides onto salt or spray drops over the ocean should cause the size spectrum of nuclear debris particles to be shifted to larger sizes than observed over land. A high volume aerosol classifier consisting of cyclone precipitators followed by a pack of filters of graded porosity has been designed to measure the size distribution of radioactive aerosols. It will be operated both at sea and over land during several different wind and spray conditions. Air concentrations of fission products are being determined by high volume air filter sampling at four North Atlantic Ocean weather stations. A monthly estimate of spray over blocks of the ocean will be made from synoptic weather charts, and by integrating observed air concentrations, the deposition of Sr-90 due to spray will be estimated.

No systematic difference has been found between air concentrations of fission products at the ocean weather stations and at land stations at equivalent latitudes, although final conclusions await additional data collection. Several cyclone precipitators have been evaluated, and a radioactive particle classifier has been designed.

SUPPORTED BY U.S. Atomic Energy Commission

6.0165, RADIOSTRONTIUM DEPOSITION OVER THE OCEAN

E.P. HARDY, U.S. Atomic Energy Commission, Operations Office, *New York, New York*

Samples of ocean water collected by the Woods Hole Oceanographic Institution are analyzed for Sr-90 under AEC contracts administered by HASL. Most of the samples are collected at four Coast Guard Weather Stations in the North Atlantic. Other samples are taken at available locations for ocean circulation studies. The Coast Guard stations are also equipped to sample air particulates and fallout over three-week periods. The data are used to estimate the total fallout delivery to the sea surface and to trace the source of seawater at specific locations. A stationary platform has been erected 25 miles northwest of Andros Island on the Great Bahama Banks. Fallout collectors and rain gauges have been mounted on the platform to measure monthly concentrations of radiostrontium in precipitation. Seawater samples and sediment cores will also be collected for Sr-90 and C-14 analyses. From the C-14 analyses, to be performed by the Lamont Geological Observatory, the age of the water can be estimated to correct the Sr- 90 seawater measurements for dilution by deep ocean water. The Sr-90 data will be compared with deposition data obtained at land stations in the same latitudinal region to determine whether the fallout rate in an oceanic environment is significantly different than fallout onto a land surface.

From measurements made so far it appears that oceanic rainfall is less than on adjacent land bodies while fallout rates are comparable. Fallout in the oceans, by the mechanisms which cause deposition on land, has therefore probably been overestimated and additional depositional forces must be invoked to account for the observed Sr-90 in the seas.

SUPPORTED BY U.S. Atomic Energy Commission

6.0166, QUALITY STANDARDS TO DETERMINE RELEASE OF SHELLFISH FOR MARKETING PURPOSES

G. STROBEL, State Div. of Fish & Game, *Oakdale - Long Island, New York* 11769

Initially it will be necessary to hold the clams pending the results of bacteriological tests before they can be released for distribution. The holding time required will depend on correlating process time required with certain specific groups that can be determined within the time period available. If these correlations do not prove feasible, it will necessitate the design of a holding system so that the shellfish will not be released until their sanitary quality can be determined. A wet-storage system seems a reasonable approach to this problem, but dry-storage will also be investigated. This work will be done concurrently with the other phases of this sub- project. Various storage conditions will be investigated from the start of the project and will continue until an optimum condition is reached or bacterial studies prove storage unnecessary. The work will be under the direction of G. Strebal, Assistant Sanitary Engineer and J. Redman, Bacteriologist. Additional personnal include: 1 Technican.

The work will be located at the plant site in West Sayville, N.Y. with bacteriological tests performed at the laboratory in Oakdale, N.Y. All testing procedures will follow Standard Methods. Part 4 of 5

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
New York State Government

6.0167, THE ACCUMULATION OF FISSION PRODUCTS BY MARINE FISH AND SHELLFISH

T.R. RICE, U.S. Dept. of Interior, Radiobiological Lab. , *Beaufort, North Carolina* 28516 (AT(49-7)-5)

The cycling of elements in the estuarine environment is being followed by observing the movement of radioisotopes in the water, biota, and sediments. Quantitative data on the cycling of radioactive elements are important since effluents containing radioactive elements often flow into estuarine waters. With such data, it should be possible to predict the pathways taken by the radioactive elements.

The potential importance of cord grass, Spartina alterniflora, in conveying radioisotopes of zinc, manganese, and iron into estuarine food chains was evaluated on the basis of its annual production, its content of the three elements, and its annual cycle of growth and decay. An environmental tracer experiment was carried out in which naturally-occurring fallout radioactivity in the estuary served as the tracer isotopes. In the laboratory, the influence of certain environmental factors on the concentrations of zinc 65 accumulated by an experimental community was tested. Finally, the interactions of radiation, salinity, and temperature on the physiology of the estuarine fish, the mummichog, was observed.

Spartina production was found to approach one-third the total phytoplankton net production of adjacent esturaies and is thus potentially important in estuarine food chains. The unusually high iron content of the dead material suggested that Spartina may be especially important in the movement of radioisotopes of iron from water and sediment into estuarine animal populations. Concentrations of gamma-emitting fallout radioisotopes were monitored in Rangia over a 30-mile stretch of river and a salinity range of less than 0.1 to greater than 15 parts/thousands. Ruthenium 106 and ruthenium 103 were concentrated more in Rangia from downstream stations (salinity range 6-15 parts/thousand), whereas cesium 137 was more abundant in the same species from fresher water (salinity range 0-8 parts/thousand. It was found that a high salinity and zinc concentration suppressed the concentration of zinc 65 in animals and sediment, while high temperature and pH had the opposite effect. In experiments testing the interaction of salinity, temperature, and radiation, it was observed that both salinity and temperature changed the LD-50. Above 20 degrees C. fish were more sensitive to radiation at high salinites, while below 20 degrees C. fish were more sensitive to radiation at low salinities.

SUPPORTED BY U.S. Atomic Energy Commission

6.0168, SALT-WATER ENCROACHMENT IN NORTH CAROLINA ESTUARIES

H.B. WILDER, U.S. Dept. of Interior, Water Resources Division, *Raleigh, North Carolina* 27607

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of North Carolina.

Purpose: To determine the variations in flow and chemical quality of water in North Carolina sounds and estuaries so that decisions may be made regarding industrial utilization of the water.

Methods: Collect and analyze water samples, plot dispersion pattern compile and collate hydrologic information from various sources and prepare an interpretive report on the estuaries.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey
North Carolina State Government

6.0169, INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER

R.M. PFISTER, Ohio State University, Graduate School, *Columbus, Ohio* 43210

The proposed investigation is to study the interaction of environmental contaminants (defined as substance not formed biologically or naturally, and which are not normally indigenous to the water) on the microbial portion of the ecosystem. The particulate materials (detritus) will be examined on a physical, chemical, and biological basis, and the materials will be characterized using differential and gradient centrifugation in conjunction with electron microscopy. The characteristic fractions of suspended particulate material will ultimately be examined for ability to influence biological reactions. This particulate fraction of water is important to microbial relationships in the area of interfaces and biological activity. It is known that particles and molecules in solution accumulate at interfaces (this includes chemicals which can either act favorably (e.g., nutrients) or unfavorably (e.g., pesticides) to organisms) and that enzymatic reactions are concentrated at membranous surfaces. Therefore, it is of significant importance to study the capabilities of nonbiologicals that commonly end up in the waters on such colloidal or molecular interfacial systems.

The investigation will be confined to a small river or creek basin which enters into Lake Erie, and to the lake itself.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
Ohio State University

6.0170, CLADOPHORA AS RELATED TO POLLUTION IN WESTERN LAKE ERIE

C.E. TAFT, Ohio State University, Graduate School, *Columbus, Ohio* 43210

The proposed research involves mapping and quantitative studies of attached Cladophora along the shorelines and on shoals adjacent to the Lake Erie Islands, and of the detached Cladophora beds that drift across the lake bottom. The approach will determine the quantity of Cladophora on the basis of dry weight, its periodicity, the chemical composition relative to that of the lake water, and the relationship of Cladophora to oxygen concentrations over the beds. Studies to evaluate harvested Cladophora as special products such as fiberous filter material, food, and/or as a mulch will be initiated.

Field investigations include: 1) Aerial mapping of Cladophora beds. 2) Observations of periodic growth on the beds. 3) Quantitative measurements of Cladophora on attached and drifting beds. Laboratory invesgigations include: 1) Chemical analyses of Cladophera. 2) Chemical analysis of lake water. 3) Culture of Cladophora. 4) Suitability of Cladophora as a special filter medium. 5) Suitability of Cladophora as an animal food supplement. 6) Suitability of Cladophora as a speciality mulch.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
Ohio State University

6.0171, MICROFLORA OF RADIATION PASTEURIZED SEAFOODS

A.W. ANDERSON, Oregon State University, Agricultural Experiment Sta. , *Corvallis, Oregon* 97331

1. Determine the numbers and the radiation resistance of microorganisms surviving radiation pastuerization. 2. Determine whether those surviving microorganisms constitute a health hazard. 3. Determine the shelf life of such radiation pasteurized seafoods under various temperatures of storage. 4. Establish D or comparable values for radiation destruction rates of selected pathogens.

This investigation was concerned with the effects of pasteurization irradiation on the flavor and extension of storage life of shrimp and crabmeat held at 38 degrees F. The pasteurization levels selected on the basis of the flavor threshold values were 0.50 and 0.75 megarads for shrimp and 0.25 and 0.50 for crabmeat.

Chemical and bacteriological analyses were conducted on the non- irradiated and irradiated samples held at 38 degrees F. These included trimethylamine nitrogen, total volatile bases, total volatile acids, pH, and total plate counts on various selective media. Flavor evaluations were made by a trained panel for the presence and intensity of irradiated taste and odor.

SUPPORTED BY Oregon State Government

6.0172, ECOLOGICAL STUDIES OF RADIOACTIVITY IN THE COLUMBIA RIVER ESTUARY AND ADJACENT PACIFIC OCEAN

W.V. BURT, Oregon State University, Graduate School, *Corvallis, Oregon* 97331 (AT(45-1)-1750)
PEARCY

Neutron-induced radionuclides, originating primarily from the nuclear reactors at Hanford, Washington, are continually introduced into the Columbia River estuary and adjacent Pacific Ocean. The presence of Zn65, Cr51, Sc46, Mn54, Co60, and several other radionuclides in dilute, but often measurable concentrations, permits studies of the cycling of these elements.

Studies in the estuary which have already been defined show that the levels of radioactivity and distribution of radionuclides in water, sediment, and biota will concentrate on specific activities (activity of radionuclide per gram of total element) in various components of the ecosystem to determine reservoirs, routes, and rates of transfer.

In offshore areas, planktonic and nektonic organisms will be collected from discrete depths using electrical cable to monitor depth and actuate opening and closing devices. A special study will be made of vertical migrations of euphausiids. Radioanalysis and stable element analysis of midwater and benthic animals from various depths will enable estimates of vertical changes in radionuclide levels and vertical transport rates. Comparisons between specific activities of zinc in animals and water will be attempted in the plume region. Study of seasonal and regional variations of gamma emitters in albacore, tuna and salmon, which have provided insight into the migratory behavior of these species will be completed.

The radioecology of benthic organisms on the continental shelf and slope is being studied along the northern Oregon coast. Stomach contents will be analyzed and food webs will be delineated and related to radionuclide distribution. A deep-sea camera linked to a sediment sampler will help relate bottom topography to the sediment and infauna. Animal-sediment relationships, which have already been shown to be important aspects of benthic radioecology, will become more meaningful when viewed in terms of specific activities.

SUPPORTED BY U.S. Atomic Energy Commission

6.0173, AN ECONOMIC EVALUATION OF WATER POLLUTION CONTROL, YAQUINA BAY, ORE

E.N. CASTEL, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

OBJECTIVE: (1) Identify the items of economic value that will be sacrificed if pollution is not controlled in a particular case study situation. (2) Insofar as possible, determine the unit prices and physical quantities of those items of economic value identified in (1) above. (3) Determine the cost of alternative engineering plans designed to provide for varying degrees of pollution control. (4) Relate the above variables in a mathematical model that will permit the unknown physical, biological and economic data to be isolated. (5) Relate the unknown variables in (4) above to needed research in the physical, biological and economic fields. This work will involve the establishment of a complete mathematical model which will relate all monetary elements of benefits and costs. It will be necessary to make quantitative determination of so many of the benefits and cost items as possible. It will then be necessary to solve for the crucial range of values for the unknown variables. The results of this case study will then be related to the more general problem of benefit-cost analysis in water pollution control.

SUPPORTED BY Oregon State Government

6.0174, COASTAL DIFFUSION OF POLLUTANTS

D.J. BAUMGARTNER, U.S. Dept. of Interior, Pacific Nw. Water Laboratory, *Corvallis, Oregon* 97330

The Georgia-Pacific Corporation, Toledo, Oregon currently discharges its kraft process pulp mill wastes to an ocean outfall which discharges approximately 6 million gallons per day through a diffuser section at a depth of 40 feet at a distance of 3000 feet off the Oregon Coast at Newport. The dilution achieved by the diffuser process and by the horizontally flowing field under the influence of natural forces will be investigated by frequent sampling of the near coastal waters, plus continuous monitoring of wind direction and speed. Current meters will be installed at various depths and at three locations in the near shore area to determine the relationship between the dilution of the field and the current structure. Additional surface current measurements may have to be made on the basis of drift cards or dye fields. Model tests will be performed in an 8-foot diameter, 3-foot deep tank to reproduce the hydrodynamic characteristics of the diffuser port and the density structure or the wind stress. This should, in addition to improving the methodology for describing jet diffusion, provide a method for estimating the influence of the non-steady current structure in the receiving fluid by comparing the observed performance in the prototype with the observed performance in the controlled model.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0175, ESTUARINE DIFFUSION OF POLLUTANTS

D.J. BAUMGARTNER, U.S. Dept. of Interior, Pacific Nw. Water Laboratory, *Corvallis, Oregon* 97330

The most general characteristic of pollutants which plays a part in the assessment of their fate is concentration. Since the concentration is a function of its dilution in the environment as a result of mixing and diffusion, as well as decay of the component, it is of considerable importance to be able to determine how the concentration of a pollutant will vary in the receiving water at various locations and perhaps at various times if the pollutant or the environment is not in steady state.

Uncertainty exists with regard to the value of the turbulent diffusion coefficient to be used in problem analysis. To provide a means of determining this value at points in time and space, as well as providing additional understanding of the forces which influence estuarine diffusion, a predictive model of salinity will be constructed on the basis of time series analysis of observations in Yaquina Bay, Oregon.

Continuous recording salinometers will be installed approximately every five miles along Yaquina Bay to obtain the record of the time variation of salinity at the surface. Once a week, vertical traverses of salinity will be obtained to provide information on the vertical stratification in the estuary. If necessary, additional salinometers will be placed near the bottom to obtain information on the vertical distribution. Fresh water inflow will be estimated by stream gauging of the three principal surface streams in the area. Direct runoff and direct rainfall can be estimated. Information on tide height and frequency will be obtained from three tide gauges, while continuous information on wind speed and direction will be obtained at the entrance to the bay and other locations if necessary.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0176, MARINE BIOLOGICAL ASSESSMENT OF POLLUTIONAL FATE

D.J. BAUMGARTNER, U.S. Dept. of Interior, Pacific Nw. Water Laboratory, *Corvallis, Oregon* 97330

In almost every pollution situation, a major consideration is the impact of the degraded water quality on the organism. This is especially true where it is suspected that the pollutant will harm aquatic organisms of primary importance to man. Interpretation of bioassay tests is complicated by the fact that there has been very little information obtained to relate the controlled observations in the laboratory experiments to the actual conditions existing in the environment in the absence of pollution. Attempting to overcome some of these difficulties, investigators have begun to consider and apply in situ bioassay procedures.

The difficulties associated with this approach are related to selection and maintenance of the test animals, knowledge of their population dynamics in the natural unpolluted environment, and determination that the observations obtained under the test conditions are due to a pollutional stress rather than artifacts of the experimentation.

The first step in developing a series of procedures for analysis of problem areas is determining the amount and type of information necessary to describe the natural environmental populations. This developmental work is being tried on Yaquina Bay, Oregon, along two approaches.

Information on fish usually associated with bottom or midwater habitat will be obtained at each of ten sampling stations every two weeks by means of a trawl. Continuous recording of salinities on the surface at six stations covering the trawl areas will also be provided. In addition, weekly profiles of dissolved oxygen, temperature and salinity will be provided. Samples will be obtained for organic carbon analysis or PBI's or other appropriate analyses to determine possible pollutants. It will be possible to test some of the methods of analysis after collection of data for one year. The second method of observation pertains to collection of crustacea in standardized substrate boxes and on substrate media suspended in the water column. These samples are analyzed after exposure to the environment for five weeks. Sub- samples of the organisms obtained in both methods will be analyzed for maturity, weight distribution, and stomach contents.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0177, DISPOSAL TO MARINE WATERS

R.J. CALLAWAY, U.S. Dept. of Interior, Pacific Nw. Water Laboratory, *Corvallis, Oregon* 97330

This project is concerned with oceanography of coastal waters and estuaries necessary to protect them from the disposal of municipal, industrial, and vessel wastes. Coastal work will consider the diffusion and advection of wastes discharged from outfalls, the accumulation of wastes on the bottom near outfall, and eventually, the effect of various wastes on marine organisms. A project on the effect of wastes discharged from vessels will be initiated in 1966. Estuarine work will consider saltwater penetration, continuous monitoring of parameters, statistical and dynamical models of the environment.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0178, MOVEMENT OF RADIONUCLIDES IN THE LOWER COLUMBIA RIVER

W.L. HAUSHILD, U.S. Dept. of Interior, Water Resources Division, *Portland, Oregon* 97208

The objective of this project is to quantitatively determine the concentrations and loads of specific radionuclides that are solutes and sorbed on sediments in the Columbia River from Hanford, Washington to the estuary. The spatial and temporal variation and distribution of the radionuclide concentration and loads are to be studied, and an approximate budget of the radionuclides is to be determined.

The physical, chemical and mineral properties of the suspended and streambed sediments are being studied; and these properties, insofar as is possible, will be related to sediment transport, sorbed radionuclides, and the equilibrium balance between the solute and sorbed radionuclide phases.

The extent and characteristics of sediments deposited on the streambed and sorption of radionuclides by these sediments in the natural channel, reservoir, and tidal-affected reaches are being surveyed.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

6.0179, MOVEMENT OF RADIONUCLIDES IN THE COLUMBIA RIVER ESTUARY

D. HUBBEL, U.S. Dept. of Interior, Geological Survey, *Portland, Oregon* 97208

Two reaches of the estuary have been instrumented for discharge determination. These will be calibrated by direct measurement of flow from a boat at different stages and through several tidal cycles during the coming year. The data will then be fitted to a one dimensional mathematical model that has already been developed. If the mathematical model is determined to be reasonably accurate, two other reaches will be instrumented similarly. In addition, water samples for salinity and other chemical characteristics and sediment content will be taken during all direct discharge measurements. Gross description of radioactivity in the estuary will be obtained by a sled-mounted in situ radiation detector as well as from analyses of water and sediment samples. Data compilation and integration will be augmented by a study of typical environments such as islands, tidal flats and shorelines, which can be mapped fairly easily. The mechanics of sediment transport and deposition particularly under the influence of salinity changes and flow reversal will be studied to define empirical relations to be used in calculating sediment loads.

SUPPORTED BY U.S. Atomic Energy Commission

6.0180, THE MOVEMENT OF RADIONUCLIDES IN THE COLUMBIA RIVER ESTUARY

D.W. HUBBELL, U.S. Dept. of Interior, Water Resources Division, *Portland, Oregon* 97208

Certain radionuclides enter the Columbia River from the Hanford installation of the U. S. Atomic Energy Commission. Part of the radionuclides remain in solution in the water, part are sorbed on the fluvial sediment, and part are taken up by the biota. As a result, each medium, by virtue of its motion, affects the distribution of the radionuclides.

Objectives of this project are to define the disposition and movement of radionuclides in the Columbia River estuary; to study the processes that influence the movement of radionuclides, particularly the sedimentation, flow and chemical processes; and to contribute to estuarine technology.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

6.0181, DETERMINATION OF SAFE LEVELS OF POLLUTION IN PUERTO RICO

A.S. VAZQUEZ, Univ. of Puerto Rico, Water Resources Research Inst., *Mayaguez, Puerto Rico*

Some Puerto Rico Bays are receiving raw sewage and other organic pollution in high concentrations. Damage has been done to the fish population and to the recreational use of surrounding beaches, the best example being the Bay of Mayaguez just near the Campus of the College of Agriculture and Mechanic Arts where the Institute will have its headquarters.

It is proposed to investigate the degree of contamination of the bay to evaluate the proportional effect of the different factors which contribute directly to its actual and future sanitary conditions and its effects on the fish, ecology and the recreational aspect of the bay and surroundings.

This study will be carried on through the systematic measurement of parameters such as BOD, dissolved oxygen, solids, coliform group, biota, etc. Similarly, physical, chemical, and meteorological factors affecting the locality of the Mayaguez Bay will also be determined inside the bay. The goal will be to establish the relationships among the most important of the factors that enter into the problem, with the purpose of establishing criteria for prediction for similar situation in tropical bays.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Puerto Rico

6.0182, ASPECTS OF RELATIONSHIPS BETWEEN MARINE ECOLOGY AND HUMAN HEALTH

C.N. SHUSTER, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Ne. Mar. Hlth. Sc. Lab., *Narragansett, Rhode Island*

Continuing independent and collaborative studies in marine health science upon aspects of the marine environment and biota which have a bearing upon human health. Emphasis is upon biological, particularly ecological, observations upon toxins and other harmful chemicals, beneficial substances, disease-transport mechanisms, etc.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0183, USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS

T.E. MALONEY, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab., *Wakefield - Kingston, Rhode Island* 02881

This study is concerned with the development of bioassay methods and techniques, employing marine planktonic organisms, or determining the identity and of pollutants in the marine environment and for deter- mining and predicting the short and long-term effects of lethal and sublethal concentrations of pollutants upon other organisms found in the the marine environment. This includes the development of methods for determining and measuring the effects of pollutants upon sensitive metabolic responses and enzymatic reactions both at the cellular and subcellular levels and devising methods for accomplishing such bioassays accurately and routinely.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0184, COMPARATIVE TOXICITIES OF METALS TO ESTUARINE FISHES

R. EISLER, U.S. Dept. of Interior, Natl. Marine Water Qual. Lab., *West Kingston, Rhode Island* 02892

Disposal of solid wastes at sea is being practiced by an increasing number of municipalities. Prelimianry analysis of incompletely-ashed incinerator wastes by atomic adsorption indicates that aluminum, iron, calcium, zinc, sodium,, potassium, and lead--in that order--are most abundant. Short-term bioassays with inorganic salts of these and other metals to the mummichog, Fundulus heteroclitus, are being conducted under controlled environmental conditions. Relationships between mortality, physical-chemical environment, and concentration of test metal in solution is being investigated.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0185, RADIONUCLIDES IN THE SAVANNAH RIVER ESTUARY AND ADJACENT COASTAL WATERS

C.M. PATTERSON, U.S. Atomic Energy Commission, Savannah River Plant & Labs., *Aiken, South Carolina*

Small amounts of radionuclides are released to the Savannah River by the Savannah River Plant 170 miles from the Atlantic Ocean. The distribution of radionuclides in the river's estuary and in adjacent coastal waters is being determined. Effects of water exchange between the estuary and ocean, sedimentation and other physical and chemical factors influencing dilution and distribution will be studied.

SUPPORTED BY U.S. Atomic Energy Commission

6.0186, STEROLS AND LIPIDS IN WATER POLLUTION

L.L. SMITH, Univ. of Texas, School of Medicine, *Galveston, Texas*

The presently proposed work considers the examination of natural waters for their lipid content, particularly their sterol content (including cholesterol and the fecal sterol coprosterol). It is hoped that a full knowledge of the sterol content of natural waters will permit the use of such analyses for sterols for recognition of pollution from domestic sewage, animal and plant wastes, etc. as these might be encountered in natural water supplies. Both animal and plant material contains sterols, and by detecting a given key sterol in excess in a water sample it should prove possible to identify the probable origin of the sterol. Furthermore, knowledge of the sterol content should offer a fundamental basis for our improved understanding of the means by which lipids and sterols are disposed of in natural waters. Water samples have been taken from open surf, quiet bay, running tidal, and domestic sewage treatment effluents and the sterols therein analyzed by chromatographic means. In open uncontaminated waters certain phytosterols have been found but no evidences of domestic sewage contamination were obtained. Domestic sewage does contain cholesterol and coprosterol, even in fully treated sewage. The fate of these sterols as they are diluted in water sources is under study.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0187, EFFECTS OF RIVERS ON THE METABOLISM OF TEXAS BAYS

B.J. COPELAND, Univ. of Texas, Graduate School, *Port Aransas, Texas* 78373

The overall objective of the research proposal is to seek ways to distinguish the degree to which a body of water is polluted, ascertain the contribution of rivers to the bay, and to discover quantitative and qualitative differences between polluted and unpolluted coastal waters. Comparisons of concentrations of various nutrient compounds to primary productivity and various animal and plant assemblages will be made and the river's contribution to the bay will be evaluated.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0188, A STOCHASTIC MODEL FOR POLLUTION IN ESTUARIES

R.G. KRUTCHKOFF, Virginia Polytechnic Institute, Research Division, *Blacksburg, Virginia* 24061

The purpose of this investigation is to find a stochastic model for pollution and dissolved oxygen in estuaries. With this model it will be possible to predict the proportion of time that pollution will be above any given concentration or that dissolved oxygen will be below any given level. It is hoped that this information will result in better management of water resource systems and aid in forming more realistic restrictions on the use of estuaries for disposal of pollutants.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0189, FALLOUT INVENTORY OF THE OCEANS AND RELATED MECHANISMS

J.J. FUGUAY, Battelle Memorial Institute, *Richland, Washington* 99352

This study is to provide information to assess the inventory of fallout radionuclides in the several spheres of the Earth. At present, a mass balance of material released against the inventory in the atmosphere, on the land surfaces and in the sea cannot be made to the accuracy desired. Measurements of the history and distribution of radionuclides produced in weapons testing residing in the atmosphere plus those depositing on terrestrial surfaces have permitted tentative calculations of the inventory in the sea by assigning there all unmeasured inventory. From such a calculation, the rate of deposition over the ocean must be about 50% greater than over the land, but the required mechanisms are unclear. Recently, we have developed methods to establish the inventory in the sea through analysis of the water; this will contribute to the knowledge of the distribution of fallout on Earth. Investigation of the exchange processes between air and sea, and air and land, and using knowledge of debris transport and the atmospheric and terrestrial inventory of fallout, the difference in rates will be measured and the mechanisms defined.

This is a new program but applicable progress was made here under other AEC studies. Methods were developed and used for ten trace elements in sea water by neutron activation and counting on multidimensional and Ge(Li) diode gamma-ray spectrometers. Research continued on the behavior of airborne radionuclides and was expanded to include sampling at Pt. Barrow, Alaska, and Rio de Janeiro.

The behavior of 55Fe in the ocean was clarified. Tuna from the northern hemisphere were about 20 times as active as those from the southern. New techniques used cosmic-ray-produced radionuclides as tracers of the normal atmospheric aerosols. Aircraft sampling was integrated into the work.

SUPPORTED BY U.S. Atomic Energy Commission

6.0190, COLUMBIA RIVER SEDIMENT STUDIES

J. NIELSEN, Battelle Memorial Institute, *Richland, Washington* 99352

PNL provides analytical services for the Columbia River and estuary studies being conducted by the USGS for the AEC, aids in the evaluation of the fate of the radionuclides, especially in the area of effect of retention by sediments, and conducts geochemical studies involving mechanisms of radioactivity uptake by the sediments.

SUPPORTED BY U.S. Atomic Energy Commission

6.0191, BACTERIOLOGICAL AND ESTHETIC OF PLEASURE BOAT WASTE DISCHARGE ON SMALL HARBORS

R.W. SEABLOOM, Univ. of Washington, School of Engineering, *Seattle, Washington* 98122

The proposed research will involve field studies to determine and document the bacteriological pollution caused by the waste discharge from small pleasure craft in small harbors. Both fresh water and salt water harbors will be studied. The possible esthetic degradation of water quality will also be determined by visual surveillance of the water during periods of maximum boat activity. The bacteriological analysis will be initiated in the field and will be by the membrane filter technique.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Washington

6.0192, INFLUENCE OF INDUSTRIAL AND MUNICIPAL WASTES ON ESTUARINE AND OFF SHORE WATER QUALITY

J.F. SANTOS, U.S. Dept. of Interior, Geological Survey, *Tacoma, Washington*

This project is being carried on in cooperation with the Municipality of Metropolitan Seattle.

A major objective is to study the influence of industrial and municipal waste disposal on all phases of water quality, chemical, physical, ecological, and sanitary in fresh, brackish, and saline environments. Measurements made with multiple parameter water quality recorders at four sites on the Duamish River estuary are the basis for the attempted correlations. Parameters recorded include dissolved oxygen, specific conductance, water temperature, pH, turbidity and solar radiation index. Computer programs will be written to analyze these data and to detect significant relations.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7. MARINE GEOLOGY

7A. ECONOMIC GEOLOGY

(location, Origin, and Grade of Marine Mineral Resources.)

7. MARINE GEOLOGY

7.0001, AN APPROACH TO MARINE RESOURCE DEVELOPMENT IN ALASKA

D.W. HOOD, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

The marine resources of the State of Alaska are considered to be of great value. While some exploration and development of seafood, petroleum and minerals has occurred, little in the way of planning for such activities has been done. This project consists of a study which will provide: a basis for curriculum planning for eduation, an appraisal of Alaskan marine resources, establishment of priorities for research and identification of the most useful areas for early development.

A committee of ten experts, five from Alaska and five from other states, will prepare a report which is to serve as a guideline for marine resource development in Alaska. The committee members will compile existing information on Alaskan marine resources, visit specific areas of such activity and prepare the report.

SUPPORTED BY U.S. National Science Foundation

7.0002, A UNIFIED APPROACH TO WATER, FOOD AND POWER IN A COASTAL DESERT COMMUNITY

C.N. HODGES, Univ. of Arizona, Inst. of Atmospheric Physics, *Tucson, Arizona* 85721

The University of Arizona is developing a combination system for providing power, water and food. The system is designed for use, initially at least, in a coastal desert area.

Power is generated by a diesel-electric set. Waste energy from the diesel engine is utilized to heat seawater for a humidification desalination plant. The waste seawater from the desalination plant is used to provide the temperature and humidity control for a closed- environment greenhouse. Carbon dioxide from the diesel engine exhaust is used in the closed greenhouse to accelerate plant growth.

Various experimental components of the system have been constructed and tested at the Environmental Research Laboratory, Tucson, Arizona. A pilot facility is being developed at Puerto Penasco, Sonora, Mexico, in cooperation with the University of Sonora.

SUPPORTED BY Rockefeller Foundation

7.0003, SAMPLING CAMPAIGN ON CORONADO BANK, OFF SOUTHERN CALIFORNIA

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DAVIS

The project commenced field operations in May 1968 with a comprehensive survey involving seismic, magnetic, surficial dredge and grab sampling and underwater photography of the Coronado Bank above the 100 fathom contour. The shallowest water depth encountered in this preliminary work was approximately 57 fathoms (342'). Thus far, the deepest penetration of bottom sediments on the bank has been mostly surficial, measuring less than 2 feet, and recovery of an undisturbed core has not been attempted.

The anticipated sampling campaign on Coronado Bank will provide the first truly three-dimensional measurement of sediments overlying the bedrock surface and hopefully the first undisturbed core sample. The purpose of this project is not only to measure and evaluate the phosphate content and target reserves, but also provide the opportunity to test systems for deep water drilling capability. The surficial sampling just completed (as outlined in Project VIII-C-1) has not been analyzed as of this writing, and therefore results regarding P2O5 content are not available to report. However, photographic recovery via underwater television indicates large areas of unobstructed sand bottom with occasional boulder-sized nodules. Several smaller areas indicated a relatively high density of phosphate nodules. Seafloor bathymetry, bottom characteristics and depth of overburden to the bedrock are presently being determined.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

7.0004, ANALYSIS AND INTERPRETATION OF DATA FROM GEOPHYSICAL AND PHOTOGRAB SURVEY OF CORONADO BANK, OFF SOUTHERN CALIFORNIA

H.D. HESS, U.S. Dept. of Interior, Marine Min. Technol. Ctr., *Belvedere - Tiburon, California* 94920
MCFADDEN

Background information regarding potential southern California offshore phosphorite target areas has been provided in a two-volume portfolio of technical papers concerning the subject. This compilation has been circulated to all Team members. The collection contains 46 papers, as well as a selected bibliography of 40 additional references.

The target selection was made on the basis of several factors. First, previous work done by Drs. K.O. Emery, R.S. Dietz, F.P. Shepherd, and others indicated that Coronado Bank has potential as a prime phosphorite area. The second basis for target selection was related to water depth and size of the target area. Coronado Bank above the 100 fathom line represents an area of approximately 18 square miles, most of which is relatively flat and unobstructed. Also, visibility for underwater photography and videotape television work was considered to be very good. The third basis for selection concerned the logistics: The Coronado Bank target area is in close proximity to San Diego which offers harbor protection for craft the size of the R/V CRIPPLE CREEK.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

7.0005, GEOLOGICAL, GEOPHYSICAL, OCEANOGRAPHIC, AND ECOLOGICAL DATA ON WORLDWIDE BASIS, ON AREAS OF HEAVY METALS POTENTIAL

H.D. HESS, U.S. Dept. of Interior, Marine Min. Technol. Ctr., *Belvedere - Tiburon, California* 94920

A survey of existing mineral resource and sampling data has been in progress to establish the location and general character of known and potential areas of seafloor mineralization on the Pacific Coast continental shelf. During the past year, major emphasis has been placed on nearshore precious-metal placers in the northern California- Oregon heavy-metal placer areas. Based on collected data, several potential offshore target areas for each of these were selected for field studies involving both drilling and deposit characterization.

Results of USGS reconnaissance missions and data from other sources have pointed up five nearshore heavy-metal target areas off the Oregon coast and two areas off northern California. Climatological data for these areas have been reviewed and analyzed with the selection of August and September for drilling operation which are to be conducted from the R/V VIRGINIA CITY.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

7.0006, MARINE HEAVY-METALS PRODUCTION INFORMATION, ON WORLDWIDE BASIS

H.D. HESS, U.S. Dept. of Interior, Marine Min. Technol. Ctr., *Belvedere - Tiburon, California* 94920

Information on worldwide offshore minerals production has heretofore been collected and disseminated on an informal basis or as an incidental part of other MMTC data collection efforts. With inception of this project, heavy-metals production information will now be collected, analyzed and disseminated on a formal project basis, with a view to worldwide coverage. Major emphasis will be placed on the characteristics of the deposits, mining history and recorded production, mining and sample processing systems employed, the recoverability factor, operating costs, and a number of other technological aspects of the operations.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

7.0007, EVALUATION OF CONTEMPORARY ACOUSTIC, MAGNETIC AND GRAVIMETRIC METHODS FOR DETERMINING SIZE AND SHAPE OF DEPOSITS

H.D. HESS, U.S. Dept. of Interior, Marine Min. Technol. Ctr., *Belvedere - Tiburon, California* 94920

Study and analysis of available marine geophysical instrumentation and techniques to date at this Center have been largely concentrated on acoustic subbottom profiling and marine magnetometer systems as related to the previous broad geophysical project and development of the Center's inhouse capability with respect to geophysical instrumentation. Under this current project, a detailed study and analysis of all present state-of-the-art acoustic, magnetic, gravimetric, as well as related bore-hole logging instrumentation and techniques having possible application to detailed deposit characterization activities in the marine environment will be conducted on a formal project basis.

Included in this effort will be appraisal of contemporary bottom and subbottom profiling, magnetrometer/gradiometer, gravimetric systems, and down-hole geophysical logging techniques applicable or adaptable to the marine environment. Detailed comparisons will be made of each suite of systems with a view to definition of their performance capabilities for characterizing placer deposits of variable thickness, composition, and environment.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

7.0008, FEASIBILITY STUDY OF THE USE OF ELECTRICAL METHODS FOR DETERMINING SIZE AND SHAPE OF DEPOSITS

H.D. HESS, U.S. Dept. of Interior, Marine Min. Technol. Ctr. , *Belvedere - Tiburon, California* 94920

Preliminary investigative work on a towed electrical self-potential system for delineating oxidized mineral deposits or ore bodies at the seafloor was initiated at this Center during FY 68 during which time the Project Leader was employed on the Center's geophysical staff. Following recent modifications to the original prototype system and development of more sensitive electrodes, the system has shown promise of becoming a useful tool for delineating self-potential anomalies in mineral deposits at sea. Self-potential or spontaneous potential technique for many years has been successfully used on land for logging oil wells and mapping sulfide deposits. Although the anomalies in the ocean and the techniques to be employed are not the same as those on land, a marine version of the self-potential system applied on land now appears to be feasible. The marine aqueous environment has a tendency to somewhat mask reduced mineral bodies, but this is not considered to be a problem. Further, the aqueous environment allows for continuous traversing and recording in contrast to land deposits, where the technique involves the laborious task of emplacing and wetting each electrode for sufficient contact. Contact on land is difficult due to the insulating properties of dry earth and clays, whereas, contact with the highly conductive sea water is relatively easy.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

7.0009, OREGON-NORTHERN CALIFORNIA PLACER DEPOSITS

R.D. OBRIEN, U.S. Dept. of Interior, Marine Min. Technol. Ctr. , *Belvedere - Tiburon, California* 94920

Reconnaissance surveys by the USGS and the Department of Oceanography of Oregon State College have outlined five areas off the southern Oregon coast and two areas off the northern California coast which indicate zones of concentrations of heavy minerals. Preliminary plans were started in the second quarter of FY 1968 in cooperation with USGS for testing these promising zones by drilling. The team concept of project coordination and management was initiated with the appointment of a team-coordinator-manager and members of the team representing all components of MMTC.

Meetings of the team members have been held to acquaint each member with the problems of the other members, to keep avenues of liaison open, and to coordinate the various efforts towards a preparation completion date of July 1, 1968.

Close liaison with the USGS Office of Marine Geology and Hydrology at Menlo Park has been maintained to exchange technical data and coordinate the planning activities. Drilling sites as planned by the USGS have been transfrred to navigation charts to aid in closer ship's positioning.

A review of data received from the U.S. Naval Oceanographic Office in Washington, D.C. concerning wind, sea, and swell conditions in the coastal areas concerned, indicates that approximately 50 per cent of July and August will be suitable for drilling operations. The remainder of the year would provide less than 50 per cent available drilling time.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

7.0010, MARINE GEOLOGY OF THE CALIFRONIA CONTINENTAL BORDERLAND WITH EMPHASIS ON FUTURE ECONOMIC DEVELOPMENT AND GENERAL RESOURCE VALUE

D.S. GORSLINE, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

Presently includes studies of the heavy metal and heavy mineral content of coastal beaches and the shelf off southern California, clay mineral contribution from principal streams, general sediment mineralogy in river bottoms and beaches, sedimentary characteristics of marine basins in the Borderland, phosphorite distribution and internal structures, and special projects covered in part by contract funds including geology and sediment distribution of Lake Tahoe and clay mineralogy of shelf sediments off the northwestern Alaska coast.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0011, THE ECONOMIC POTENTIAL OF THE MINERAL AND BOTANICAL RESOURCES OF THE U.S. CONTINENTAL SHELF AND SLOPE

L. FISCHMAN, Economic Associates Inc. , *Washington, District of Columbia*

The study is designed to provide an initial survey of the mineral and botanical resources of the United States' continental margins, along with a preliminary appraisal of their potential economic value and the status of their development. The goal is to furnish data upon which analytical evaluation of Federal policies and programs can be based.

The most significant materials potentially producible from the marine environment will be covered with the choices based upon occurrence, apparent public interest, and relative importance in the total U.S. economy. Materials which will receive the greatest attention include: oil and gas; manganese; phosphorus and phosphates; sulfur; aggregates; calcium carbonate; gold; titanium; thorium; and fresh water.

Demands as well as estimated supplies over the next 25 years will be projected based upon review of existing studies and source data. Production from existing potential non-oceanic sources will be considered for purposes of these projections. Also, the state-of-the- art and costs of extraction will be described along with potential impact of Federal research and development, or conservation programs upon the development of these marine materials. Means of Federal encouragement of the creation of the needed equipment and institutions will be explored.

SUPPORTED BY Natl. Council on Marine Res. & Engin. Dev.

7.0012, DEVELOPMENT OF OFFSHORE SOURCES OF SAND SUITABLE FOR BEACH RESTORATION AND NOURISHMENT

G.M. WATTS, U.S. Army, Coastal Engin. Res. Center, *Washington, District of Columbia* 20016

This study is to locate and quantitatively assess those offshore deposits which contain sediments suitable for beach restoration and/or nourishment. The present geographical limits of the study are from New Hampshire to the Florida Keys along the Atlantic Coast in water depths of 15 to 100 feet below low water datum. The method of exploration is twofold: (1) Geophysical (acoustic) surveys or the bottom and shallow subsurface strata in selected areas; and (2) The extraction of short (10-15 feet) cores of the unconsolidated sediments. These data are analyzed to develop two and three dimensional maps delineating areas of usable sediments which may be exploited economically. Concurrent studies are in progress to develop and refine methods of offshore dredging and delivery of the material from the dredge to the shore.

SUPPORTED BY U.S. Dept. of Defense - Army

7. MARINE GEOLOGY

7.0013, DISTRIBUTION OF HEAVY METALS, WESTERN GULF OF MEXICO

H.L. BERRYHILL, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

Three-dimensional geologic-geophysical analysis of the western part of the Gulf of Mexico to appraise the mineral and energy resources on and beneath the sea floor, and to determine geologic processes operating in the Gulf. Work will primarily emphasize the geologic parameters that control distribution, geochemistry, and economic potential of heavy metals such as gold, platinum, chromium, tin, etc., but future work will be broadened to meet the needs of the total goals. This study is being performed in coordination with the Texas A & M University under a joint research contract.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0014, MISSISSIPPI DELTA

H.L. BERRYHILL, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

Determination of Pleistocene and Recent history of the Mississippi Delta, the geologic parameters that control distribution, geochemistry, and economic potential of heavy metals such as gold, platinum, chromium, tin, etc., during this history, and the diagenetic changes occurring in the submerged part of the Delta. This study is being performed in coordination with the Louisiana State University under a joint research contract.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0015, OREGON-CALIFORNIA BLACK SANDS

H.E. CLIFTON, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

The overall objective is to evaluate the potential for economic concentrations of heavy metals and heavy minerals in beach and offshore sands along the Pacific Coast from the mouth of the Coos River in Oregon southward to the mouth of the Klamath River in California, and the heavy metal transport of major streams supplying the area. This work is being performed in coordination with the Department of Oceanography, Oregon State University, and the Department of Geology, University of Oregon, under joint research contracts.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0016, RESOURCES OF THE BERING CONTINENTAL MARGIN

D.M. HOPKINS, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

Three-dimensional geologic-geophysical analysis of the Bering Shelf to appraise the mineral and energy resources on and beneath the sea floor, study of geologic processes operating in the Bering Sea that govern formation or concentration of mineral resources, collection of data essential to the wise utilization of these resources and the development of the geologic history of the region. Project covers USGS work in direct conjunction with the University of Washington contract.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0017, SEWARD PENINSULA NEARSHORE

D.M. HOPKINS, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

Objectives are to assess the heavy-metal potential of nearshore areas adjoining the Seward Peninsula and submerged areas adjoining Little Diomede Island, Fairway Rock, King Island, and Sledge Island with emphasis on a search for submerged gold and tin placers; to establish the geomorphic history of these submerged areas, with emphasis on the identification of former positions of the shoreline, former extensions of the subaerial drainage systems, and evidence of late Tertiary and Quaternary tectonic movements; and to establish the detailed history of the last rise in sea level.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0018, MARINE-FLUVIAL INTERFACE, COASTAL OREGON

R.J. JANDA, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

Objectives of this study are: (1) To determine age and origin of marine terraces and their relation to prominent fluviatile terraces, including both those exposed and submerged, and to compare the style of terrace deformation relative to that of older structures; (2) to study weathering reactions to determine possible role of weathering in generating economically important heavy metal placer deposits and the possible stratigraphic significance of soils; and (3) to evaluate the heavy metal deposits in the area.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0019, NEARSHORE HEAVY METAL DEPOSITS OF THE GULF OF ALASKA

E.H. LATHRAM, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

Objectives of this study are to establish the abundance and distribution of heavy metals in nearshore marine deposits of the Gulf of Alaska, particularly in the known black sand areas of Kodiak Island, Yakutat Bay and Lituya Bay; to relate the concentration and distribution of heavy metals to the geologic history of the Tertiary and Quaternary periods; and to contribute to the understanding of principles of heavy metal concentration and nearshore depositional processes as they relate to glaciated terranes. To achieve these long-range goals, a coordinated five-year program between the University of Alaska and the USGS has been established under a joint research contract.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0020, NORTHERN CALIFORNIA OFFSHORE BLACK SANDS

G.W. MOORE, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

The primary objective is to establish the abundance and distribution of heavy metals in nearshore marine deposits along the coast of California north of latitude 38 degrees. This is a southern continuation of the southwest Oregon black sands area. This work is being performed in coordination with the Scripps Institution of Oceanography under a joint research contract.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0021, HEAVY METALS AND SEDIMENTATION PROCESS OF THE NORTH CAROLINA SHELF

P.D. SNAVELY, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

Heavy metal sampling on the North Carolina continental shelf south of Cape Hatteras is underway. In addition, sampling for heavy metals analysis will be carried out in Pamlico Sound on the barrier island beaches, and in esturaries and rivers. The sampling program will be coordinated with other projects concerned with interpretation of shelf history and sedimentation processes. Aspects to be investigated include heavy mineralogy, feldspar mineralogy, quartz grain morphology, grain staining, as well as more routine parameters such as size and percent $CaCO_3$.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0022, OREGON-WASHINGTON NEARSHORE

P.D. SNAVELY, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

Primary objective is to evaluate the economic potential of heavy metals in submarine and subaereal deposits of Quaternary age along coastal Oregon north of latitude 44 degrees N and along coastal Washington; preparation of land-sea geologic transects for areas containing significant deposits of heavy metals (black sands) to show distribution and thickness of deposits and relation to geologic framework.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0023, GEOPHYSICAL AND GEOCHEMICAL STUDY OF RED SEA MINERAL DEPOSITS

J.M. HUNT, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

A six weeks cruise will be made in the central and southern part of the Red Sea into the Gulf of Aden - an area known for extensive vulcanism. Plans are to (1) Make in situ measurements of the suspended matter in the brines. (2) Determine if the three brine pools are cooling off with a decrease in brine, or are heating up, or are stable. (3) Determine the precise location of the hydrothermal vent through a combination of mineral analyses, and a series of strategically located heat flow measurements. It also may be possible to determine the magnitude and time of the last hydrothermal from these data. (4) Determine the probable nature of fluids emanating from the vent by analyzing interstitial water in cores taken as close to the vent as possible. (5) Determine the size of the mineral deposits with more controlled seismic profiling plus long cores. (6) Determine the extent of vulcanism south of 27 degrees N into the Gulf of Aden and the possible presence of other mineral deposits in this southern area. (7) Extend our knowledge of the stratigraphy and micropaleontology of the Red Sea into older stages of the Pleistocene. (8) Make surface and subsurface plankton tows from the Red Sea into the Gulf of Aden to obtain the information needed for more precise paleoecological interpretation of the fossil distributions in the cores.

SUPPORTED BY U.S. National Science Foundation

7.0024, POTENTIALLY-ECONOMIC SAND AND SILT DEPOSITS IN LAKE ONTARIO, NEW YORK

D.L. WOODROW, Univ. of Rochester, Graduate School, *Rochester, New York* 14627

The geometry, thickness and regional extent of widely spaced submerged beaches in Lake Ontario between Rochester and Henderson Harbor, New York will be mapped. The offshore gravel, sand and silt deposits lying between 10 and 100 feet depths will be studied to determine their economic quality as well as that of the landward silt and sand deposits, and to demonstrate continuity of the beaches in space and time of formation.

A fourteen day cruise over the area to be studied will be made taking continuous recording fathometer traces and subbottom profiles. Cores, dredge samples and underwater television pictures will be taken at selected sites; cores will be split and photographed on board ship, and SCUBA divers will take still photographs of the bottom and collect samples of organic materials. Lithographic logs of the cores, and grain-size and mineralogic analyses of the sands will be made. Summary maps will be compiled from bathymetric data, subbottom profiles and sediment data.

SUPPORTED BY U.S. National Science Foundation

7.0025, FORMATION AND DEGRADATION OF MANGANESE NODULES BY MARINE BACTERIA

H.L. EHRLICH, Rensselaer Polytechnic Inst. , Graduate School, *Troy, New York* 12181 (NONR)

This task is concerned with the role of the marine microbial flora in the formation and degradation of manganese nodules. The nodules, which occur abundantly on the ocean floor, contain a high percentage of manganese along with rare elements such as cobalt, nickel, titanium, and tellurium. The nodules constitute a potential source of these valuable elements.

The question of the origin of manganese nodules has intrigued oceanographers since the discovery of these nodules during the Challenger Expedition of 1873-1876. The mode of formation of the nodules, and the probable role of marine bacteria in their formation, is of direct interest to oceanographers.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0026, MARINE MINERAL RESOURCES OF THE NORTH CAROLINA CONTINENTAL MARGIN

O.H. PILKEY, Duke University, Graduate School, *Beaufort, North Carolina* 28516

00NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY North Carolina State Government

7.0027, SYMPOSIUM ON THE MINERAL RESOURCES OF THE WORLD OCEAN

J.A. KNAUSS, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

The purpose of this task is to conduct a symposium on the mineral resources of the world ocean. The symposium will be held at the Naval War College, Newport, Rhode Island, on 10-12 July 1968 to discuss the ocean in geologic time, its mineral resources, new technology and engineering in the ocean, and public policy positions concerning the oceans. The meetings will be co-sponsored by the Navy, the Geological Survey and the University of Rhode Island.

The present trend in marine sciences throughout the world is toward the exploration and exploitation of the oceans. The development of public policies, legal questions and the science and engineering involved in tapping the mineral resources of oceans are all of importance to future Naval operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0028, STRUCTURE, MINERALOGY, AND CHEMICAL COMPOSITION OF MARINE MANGANESE NODULES

R.K. SOREM, Washington State University, Graduate School, *Pullman, Washington* 99163

The fine details of structure, mineralogy, and chemical composition of marine manganese nodules will be studied. A suite of about fifty nodules representing nine ocean bottom stations off the coast of Baja, California, will be investigated. The fundamental approach involves the preparation of high-quality polished sections, the recognition and cataloging of microscopic textures, the identification of minerals present and their mode of occurrence, and determination of the chemical composition of different parts of each nodule and its relationship to textures and minerals. Those relationships which appear to be primary in any one part of a nodule may then be interpreted in terms of the probable environmental conditions at the time of formation of that part. All special features such as erosion zones, pockets of fossils and clastic grains, and cross-cutting veinlets will be interpreted in terms of nodule growth history. Finally, all of the data will be correlated and summaries of the relationships will be shown in graphic and tabular form and an attempt will be made to explain the origin of the nodules studied.

SUPPORTED BY U.S. National Science Foundation

7B. GENERAL GEOLOGICAL STUDIES

7.0029, MARINE GEOLOGY OF CONTINENTAL MARGINS

J.R. CURRAY, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

This unrestricted grant was awarded and has been used as supplementary support for the geological and geophysical research work of the investigator on sediments, structure and history of continental margins. It has supported a variety of projects covered primarily by federal grants. It also enabled completion of a study of the Holocene history of a wide strand-plain, barrier-lagoon system in Nayarit, Mexico. Lateral stabilization of the shoreline following the Holocene transgression can be demonstrated at 4750 years B.P., with seaward progradation starting between 4500 and 3600 B.P. This progradation has been by successive addition of beach ridges built atop longshore bars. Coastal climatic changes occurred at 3600 and 1500 B.P., which resulted in changes in longshore drift direction.

SUPPORTED BY Chevron Research Company

7.0030, CONTINENTAL MARGIN GEOLOGY

J.R. CURRAY, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038 (NONR)

The objective is to understand the structure, materials, and history of the continental margin. The deep structure of the bottom is explored by reflection profiling, and the information collated with that from cores and the known geology of adjacent shores. Work in progress on a book on continental margins is continuing and the manuscripts should be largely completed in 1968. During this year also, it is proposed to study the deep sea fan of the Ganges River during an SIO cruise on R/V ARGO.

A predictive capability for extrapolation to unsurveyed areas requires an understanding of: (1) the acoustic and physical properties of marine sediments, and (2) the sedimentary processes which determine these properties. This program will help provide the necessary understanding particularly with regard to continental margin areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0031, TECTONIC AND GEOLOGICAL HISTORY OF THE SOUTHWEST PACIFIC REGION

H.W. MENARD, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038

It is proposed to mount a major expedition to the Southwest Pacific during April-December, 1967 to study the tectonics, regional geologic history, oceanography and geochemistry of the general area bounded by Australia and the Kermadec-Tonga trench-New Zealand structural line. Associated studies will be made in the trench, and in the equatorial region to the north, on the initial and final expedition legs, and on the land masses adjoining the region.

The proposed expedition, the fifth in a series of Department of Earth Sciences combined summer research expeditions and graduate student field research programs, will follow the pattern of previous expeditions in attempting to integrate work at sea and on land to provide a comprehensive regional study, and in covering a broad spectrum of geological, geophysical, and geochemical studies by staff members and students. Geological and geophysical studies will include reconnaissance and detailed bathymetric surveys with precision depth recording, seismic profiles, sub-bottom sonic profiling, heat flow, magnetic, and gravity measurements, coring and dredging, and geological mapping and radiometric age determinations on associated continental and island areas within and around the region. Oceanographic and geochemical studies will be made on the water masses, their isotopic composition and dissolved gas concentrations, and on gases, water vapor, and dust transport in the marine atmosphere, sediment cores will be dated and subjected to mineralogical and chemical analysis.

SUPPORTED BY U.S. National Science Foundation

7.0032, DEEP FLOW, WATER CHARACTERISTICS, TOPOGRAPHY AND SEDIMENTS IN THE CENTRAL PACIFIC AREA

J.L. REID, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

It is proposed to measure the currents, various water properties, and sediments at abyssal depths and in relation to sea-floor structure, in critical areas of the central Pacific Ocean. Recent evidence of abyssal flow in much of the ocean and particularly in the Pacific Ocean has suggested that abyssal velocities are strong enough to be measured with simple current meters placed on the bottom. It is planned to measure these currents and examine sediment distribution where the shape of the sea floor might be expected to confine bottom currents, or where geological evidence indicates scouring of the sea floor.

SUPPORTED BY U.S. National Science Foundation

7.0033, SEA FLOOR ROUGHNESS

UNKNOWN, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (N00014-67-A-0109-0009)

Investigation of near bottom sea water properties and crustal geophysical properties are of interest to determine what influence these parameters have on sound propagation.

The improved deep tow equipment will be used to study bottom properties with particular emphasis on roughness, sound absorption, slope and magnetic properties and their effects on acoustic transmission and propagation. Documentation studies of crustal velocity anisotropy will be conducted. Observations and analyses of magnetic field anomolies near seamounts and major oceanic rises and ridges will continue.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0034, PUERTO RICO COOP - MONA PASSAGE

H.L. BERRYHILL, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

Three-dimensional geologic and geophysical analysis of the Puerto Rican shelf necessary for wise utilization of submerged land such as disposal areas for mine tailings, and assistance to the University of Puerto Rico in the development of course of training in marine geology. Evaluate oil and gas, sand and gravel, and mineral potential (including heavy metals). This study is being performed in cooperation with the Department of Industrial Research, Puerto Rico Economic Development Administration.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0035, MARINE GEOLOGY OF THE SAN FRANCISCO BAY

D.S. MCCULLOCH, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

The objectives of this project are: (1) to establish the geology of the fault-bounded bedrock basin, its structure and tectonic history, the genesis, areal distribution, thickness, composition, physical and chemical parameters, and geologic history of the unconsolidated sediments of the Bay and the bordering areas of present and former marshlands; (2) to determine the earthquake and other geologic hazards associated with the sediments; (3) to contribute to the geologic history of a significant segment of the San Andreas fault system in support of the earthquake program; (4) to determine the gold content of the fine and coarse Bay sediments derived by erosion and hydraulic mining of the Mother Lode area and deposited in the Bay; and (5) to contribute data basic to the better understanding of the hydrology of the San Francisco Bay.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0036, CENTRAL CALIFORNIA CONTINENTAL MARGIN

G.A. RUSNAK, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

The objectives of this study are: (1) to prepare intermediate-scale geologic maps of the Pacific Coast continental shelf and slope between Pt. Conception and San Francisco; (2) to obtain shallow subsurface detail relating to rocks and structures underlying the sea floor of the area; (3) to assess the geologic conditions in terms of resources that may exist within the area; and (4) to provide geologic knowledge that is needed to explore the resources of adjacent land areas, and to evaluate potential hazards related to geologic conditions within this segment of the San Andreas Fault system.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0037, SUBSURFACE GEOLOGY OF HOGSTY REEF, AN ATOLL IN THE SOUTHEASTERN BAHAMAS

M.M. BALL, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

The subsurface geology of Hogsty Reef, an atoll in the southeastern Bahamas, will be studied in order to solve two specific problems: (1) To determine the relative stand of a small atoll with respect to sea level during the last Pleistocene glacial cycle; (2) To study the paleogeomorphology of a Bahamian atoll with a view toward substantiating the proposed atoll nature of the Bahamas and comparison with the subsurface geology of some classic atolls of the Marshall Islands.

Samples from three 70 meter drill holes on the atoll will be analyzed by petrographic and geochemical means to determine the nature of the underlying strata.

Hogsty Reef is a small atoll, the coral reefs on which were probably killed off by lowered water temperatures during the

Wurmian. If subaerial erosion was an important atoll process during the glacial epochs, its effects should be well shown on Hogsty. However, lines of evidence indicate that Hogsty may be underlain by Pleistocene aeolian dunes near the present reef surface. Determination of the basement rock will be of use in worldwide studies of atoll dynamics.

Several lines of evidence suggest that the Bahamas have been atolls during the Tertiary. The aeolian dunes, if present, should be of minimal thickness and the drill cores should penetrate the Pleistocene-Tertiary boundary. The nature of underlying biogenic deposits will indicate the past geological environment.

SUPPORTED BY U.S. National Science Foundation

7.0038, SUBMARINE GEOLOGY OF THE BAHAMAS AND THE WEST INDIAN ARC

R.J. HURLEY, Univ. of Miami, Institute of Marine Science, *Miami - Coral Gables, Florida* 33124

This grant is for continued support of geological studies in the Bahamas and West Indies that have been supported by NSF Grants GP-2750, GP-2462 and GP-4197.

Following two largely exploratory cruises in the Lesser Antilles, two particular problems will be investigated. The existence of the Barbados Ridge, consisting of flysch sediments, on the southern continuation of the axis of the negative gravity anomaly of the Puerto Rico Trench, suggests partial filling and then compression of the southern part of a once more extensive trench. Understanding the geologic history of these features should provide a valuable insight on the nature of deep sea trenches. The second problem entails the detailed geology of the island arc ridge near Guadaloupe where the single arc bifurcates to a double arc. There is evidence that a second (recent) phase of volcanism in the island arc occurred to the west of the earlier activity in the northern Antilles, forming the double arc.

SUPPORTED BY U.S. National Science Foundation

7.0039, GEOLOGIC SURVEY OF MARTABAN CANYON, NORTHEASTERN INDIAN OCEAN

K.S. RODOLFO, Univ. of Illinois, Graduate School, *Chicago, Illinois*

Martaban Canyon is a large submarine valley and canyon system incised into the Irrawaddy Delta shelf and slope. The Irrawaddy Delta is one of the major river deltas of the world, yet is one of the least understood. Martaban Canyon indubitably influences sedimentation off the Irrawaddy, and affords many clues to the sedimentational and tectonic history of the delta. A geologic reconnaissance of the canyon system during the Internation Indian Ocean Expedition has been accomplished as part of a doctoral dissertation. With this reconnaissance as planning control, it is proposed that approximately 1000 nautical miles of detailed bathymetric, gravimetric and geomagnetic track be made across the valley and canyon system and approximately 10 piston cores be taken from valley and canyon axes during the 1967 global cruise of the USC&GSS Oceanographer and that these data be evaluated in the light of local sedimentation and tectonics.

SUPPORTED BY U.S. National Science Foundation

7.0040, SEA-FLOOR SEDIMENTS AND ROCK STUDIES

R.L. CHASE, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

This task concerns obtaining cores and dredge samples of sedimentary and basaltic rock in the North Atlantic Ocean, particularly over the mid-Atlantic Ridge, and making examinations of the content of these cores and those previously obtained in the North Atlantic Ocean and the Mediterranean and Red Seas. Core analyses include determinations of petrology, sedimentology, thermal conductivity, micropaleontology, and paleomagnetic stratigraphy. Cores will be photographed to provide permanent records. Ages of the sediments will be determined from micropaleontological analyses of foraminifera and from the remanent magnetism in the rocks (indicative of reversals in the ancient geomagnetic field). Sedimentation rates can be calculated from these age determinations.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0041, MARINE GEOLOGY

H.H. HESS, Princeton University, Graduate School, *Princeton, New Jersey* 08540

This research is directed toward the analysis and interpretation of geological and geophysical data from selected oceanic areas including the Gulf of Guinea, the Beata and Aves Ridges in the Caribbean, and the Gorda Ridge off the west coast of the United States. In addition, magnetic data over various oceanic regions will be compiled and analyzed for their relation to the concept of sea-floor spreading. Construction of bathymetric charts will be continued.

The effectiveness of naval operations is strongly dependent upon the physiography of the ocean bottom and the acoustic properties of the sediments in the areas of operation. This research program will help provide not only basic bathymetric and magnetic data, but also a predictive capability for extending this information into unsurveyed areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0042, GEOLOGIC INVESTIGATIONS IN PUERTO RICO & THE CARIBBEAN

P.H. MATTSON, City University of New York, Graduate School, *Flushing - Queens College, New York* 11367

The general aims of the project are to elucidate problems of Puerto Rican and Caribbean geology, mainly in the fields of volcanic and plutonic petrology, and structural geology. Problems currently under consideration include (1) major- and trace-element distributions in volcanic and plutonic rocks, (2) geochemical definition of major rock-stratigraphic units; (3) ultramatic rocks: emplacement, petrography, mineral deposits; (4) structure and petrology of basement rocks; (5) carbonate petrology; (6) chert petrology; (7) petrology and petography of basement rocks; (8) structural analysis.

SUPPORTED BY Puerto Rico Government

7.0043, COLLECTION, ANALYSIS, INTERPRETATION, AND PRESENTATION OF OCEANOGRAPHIC - GEOLOGIC DATA IN CONNECTION WITH SUBMARINE CABLE SYSTEM DEVELOPMENT

D. HAYES, Columbia University, Graduate School, *New York, New York* 10027

00NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Bell Telephone Laboratories

7.0044, UNDERWATER GEOLOGY IN THE OSWEGO AREA OF LAKE ONTARIO

A. DELPRETE, State University of New York, Graduate School, *Oswego, New York* 13126

Project objective is to study the general underwater Geology in the Oswego area. Research using underwater photography, both black and white and color, to obtain a permanent record of bottom conditions at selected locations along the shore thus sedimentary structures, rock outcrops, erosional features, and glacial features as preserved below surface can be recorded for study.

Detailed study of sand samples is necessary including examination by means of a petrographic microscope. Sand should be sub-divided so that heavy minerals can be separated and studied for different areas.

Further investigations are needed in regard to local currents and related to local winds.

SUPPORTED BY State University of New York

7.0045, GEOPHYSICAL INVESTIGATIONS OF THE SOUTHWEST MARGIN OF JAPAN

M. EWING, Columbia University, Graduate School, *Palisades, New York* 10964

The principal investigators will coordinate their work with that of Dr. Sadanori Murauchi, National Science Museum, Tokyo. They will conduct a two-ship marine geophysical survey of the southwest margin of Japan. The main purpose of the survey is to study the sediment distribution and crustal structure of the Nankei trough which extends from the mouth of Surugu Bay, Honshu, along with the foot of the island margin of southwest Japan to the southeast of Kyushu. The geophysical measurements will provide knowledge of the regional structure and may yield important clues to its development and evolution.

SUPPORTED BY U.S. National Science Foundation

7.0046, JOINT STUDY OF THE CONTINENTAL MARGIN OFF OREGON BY OREGON STATE UNIVERSITY AND THE UNITED STATES GEOLOGICAL SURVEY

L.D. KULM, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

The study of the continental margin off of Oregon includes a three-dimensional geologic-geophysical analysis of the margin. The major objectives of the program are to determine its geologic history and to appraise the mineral and energy resources on and beneath the sea floor.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0047, SEDIMENTATION, MORPHOLOGY, AND STRUCTURE--MID-ATLANTIC RIDGE

T.H. VANANDEL, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Since 1964, a small group of investigators, mostly affiliated with Scripps Institution of Oceanography and Woods Hole Oceanographic Institution, has carried out a program of detailed and integrated geological, geophysical, sedimentological, and stratigraphic studies of selected portions of the Mid-Atlantic Ridge. It is the purpose of these studies to establish in detail the structural configuration, sediment distribution, and geologic history of the Ridge, and to relate these to geotectonic concepts as, for example, sea-floor spreading. It is proposed to complete the analysis of all geophysical data, the study of the provenance of the sediments, and the geologic synthesis of information for the Vema Fracture area, and to undertake, in cooperation with scientists from Woods Hole Oceanographic Institution and the U. S. National Museum in Washington, D. C., a study of portions of the normal Ridge near 45 degrees North latitude, between 2 degrees and 15 degrees South latitude, and south of 29 degrees South latitude. Also a study will be made of a portion of the non-volcanic Walvis Ridge for comparison.

SUPPORTED BY U.S. National Science Foundation

7.0048, MARINE GEOLOGY AND GEOPHYSICS

D.C. KRAUSE, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881 (NONR)

In submarine geology the effort is directed toward an understanding of the processes affecting sedimentation on continental shelves. The approach involves detailed studies of topographic-structural sedimentation relationships in two shelf areas of the Atlantic. One of these is the area off southern New England which has the glaciated character typical of northern hemisphere shelves. The other, Northwest Africa, is uninfluenced by direct glacial action and lies adjacent to arid, semi-arid and humid coastal areas. The geophysical program involves the use of seismic profiling, magnetometer measurements, echo sounding, coring, bottom photography and dredging in an effort to understand structure and the processes involved in forming and modifying the earth's crust beneath the oceans.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0049, MARINE GEOLOGY OF THE SUB-ANTARCTIC PACIFIC REGION

Y.R. NAYUDU, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

In January 1968, the Principal Investigator on NSF Grant GA-1248 moved from the University of Washington to the University of Alaska, Institute of Marine Science at Douglas, Alaska. At the time the Principal Investigator left the University of Washington, GA-1248 was an active research grant with approximately $30,000 in unexpended funds. This proposal represents a continuation of the previous grant, with the research to be carried out at the University of Alaska by Dr. Mayudu. The UNiversity of Alaska proposes to continue the petrographical and geochemical analyses of selected samples from deep- sea cores from the USNS Eltanin. The data will be used to help determine the lithology, origin, petrology, and distribution of the sediments on the floor of the sub-Antarctic southern Pacific Ocean in the area bounded by Latitudes 30 degrees and 60 degrees S and Longitudes 120 degrees and 180 degrees W. Preliminary studies on surface lithology and geochemistry have been completed and a surface-current distribution pattern prepared. These will allow the Principal Investigator to select areas that need concentrated research. The data obtained would be used to evaluate and locate past marine isotherms and paleocurrents, to study frigid-water diagenesis, and to determine the origins of sediments of the different sediment facies.

No out-of continent travel is planned.

SUPPORTED BY U.S. National Science Foundation

7C. GEOCHEMISTRY - PETROLOGY

(composition and Dating of Rocks, Sediments, and Fossils.)

7.0050, CLAY-INORGANIC AND ORGANIC-INORGANIC ASSOCIATIONS IN AQUATIC ENVIRONMENTS

D.W. HOOD, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735 (AT(04-3)-310-3)

The overall objective of this years proposed research is to further our understanding of the chemical processes that accompany passage of sediment systems from glaciers to form marine sediments and the ancillary chemical effects of such processes on the local oceanographic environments. As in the past, the prime emphasis will be on the trace metal associations both in organic and inorganic processes. This years emphasis is on studies of the trace metal exchange equilibrium between the various size fractions of the suspended minerals and the water. The effect of organic material on this exchange will also be investigated. Analysis will be made by neutron activation techniques. In addition, concerted effort is being made to fractionate the organic matter previously found to contain significant quantities of Cu and Zn. Reverse osmosis and sephedex techniques are being employed.

Mineralogical data for both suspended and deposited sediments are complete for Taku estuary and is in press in Marine Geology. No evidence for major diagenetic changes in the minerals was observed in the estuary. The exchangeable cations on suspended sediments after contact with sea water show markedly different composition. The significance of this to flocculation processes is under study. Organic association with copper in an extractable form has been found and reported in 'Nature'. Other associations with a non-dialyzable fraction have been found and are now being characterized.

SUPPORTED BY U.S. Atomic Energy Commission

7.0051, CARBON-14 AGE PROFILE OF A HAWAIIAN REEF

W.H. EASTON, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

It is proposed to continue a coring program on Hanauma reef, Oahu, by drilling four additional core holes. In the work now planned, samples at about two-foot intervals from these borings and from cores taken in 1964 will be dated by the C-14 method. A profile of the reef will then be made in which lines of equal age can be shown. The project will establish the age of the reef, the rate of rise of sea level during perhaps the past 10,000 years, the rate of vertical and horizontal growth, and the consistency of the C-14 method in dating coral reefs.

Hanauma reef offers a rare opportunity to establish rates of reef growth both vertically and horizontally. Not only is the reef isolated in a small bay, but it occupies a unique geologic position in which it apparently grew after an explosion crater was invaded by the sea. The age of samples from the bottom of the reef therefore will not only establish the age of the reef but also a time before which the explosion craters were formed. The C-14 profile would be, so far as known, the first one made of a coral reef. It not only would provide a new method of profiling a reef, but the coring would enable a check with lithologic details and a check on consistency of samples for age-dating in a reef.

SUPPORTED BY U.S. National Science Foundation

7.0052, BIOLOGICAL FRACTIONATION OF STABLE ISOTOPES

I.R. KAPLAN, Univ. of California, Graduate School, *Los Angeles — U.C.L.A.*, *California* 90024 (AT(11-1)34-134)

The overall objective of the study is to understand the distribution of certain trace elements in the marine environment. In particular, an attempt is being made to ascertain the role microorganisms and other biological systems play in controlling the distribution at the sediment-water interface. Two approaches are being taken, (1) analysis of trace elements in the interstitial water of sediments (2) investigation of the biological fractionation of stable isotopes of sulfur by microorganisms.

It has been found that the distribution of trace elements is controlled very much by the redox system of the sediment. In the presence of hydrogen sulfide, iron and nickel appear to become solubilized. Copper, Zinc, Cadmium are generally most concentrated near the surface, suggesting contribution from organic matter. Uranium is concentrated in marine phosphate, and values as high as 500 ppm have been measured.

Investigation of the process of isotope fractionation (S34/S32) during sulfate and sulfite reduction by yeast and bacteria, indicate that the process is closely linked with the physiology and metabolic pathway of the organism and is not a sample equilibrium reaction. Fractionation factors depend on the oxidation state of the substrate and whether the organism is in a growing or testing stage.

New techniques for removal and analysis of trace elements in the ppb range have been developed.

SUPPORTED BY U.S. Atomic Energy Commission

7.0053, UPPER MANTLE OF OCEAN REGIONS

G.C. KENNEDY, Univ. of California, Inst. of Geophys. & Pla. Phys., *Los Angeles - U.C.L.A.*, *California* 90024 (N00014-67-A0111-0001)

This task is a continuation of a high-temperature high-pressure laboratory investigation of minerals and rocks that are characteristic of upper mantle materials in the earth. Previous laboratory analyses have been made on these materials to pressures of 45 kilobars, and new measurements are being made to pressures of 80 kilobars. Emphasis is on minerals that comprise tholeiitic basalt, the principal type of lava material in ocean basins and ridges. The study provides data on the distribution of melting temperatures of this rock with depth in the crust and mantle, and provides information relating to the origin of the rock in the upper mantle of the earth.

These studies are of interest to the Navy because they provide information bearing on where and by what processes rocks segregate in the upper mantle that result in the large outpouring of lava flows in the oceans, including seamounts, oceanic ridges, and oceanic islands.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0054, GEOCHEMISTRY OF NUCLEIC ACIDS

E. ROSENBERG, Univ. of California, Graduate School, *Los Angeles - U.C.L.A.*, *California* 90024

Objective: a. Problem: To extract, isolate and identify Nucleic Acids from core samples of marine samples from Mohole Project varying in depth from 0-170 meters beneath ocean floor. (The 170 meter sample geologically dated by fossils to be 30 x 10 to the 6th power years old) b. Application: Ability to detect nucleic acids in samples would provide valuable clue to existence, type of life that is (or was) present since nucleic acids play a central role in known forms of life.

Approach: Using varying organic extractives, test radioactivity of extracts for maximum nucleic acid minimum contaminants. Identification by ion-exchange and paper chromatography.

a. Reporting interval - June 2, 1964 - July 13, 1965. January 13, 1966 - July 13, 1966; July 13, 1966 - December 31, 1966 semi annual reports missing. Notified by SB. b. Analysis purine and pyrimidine bases from experimental mohole drilling of 1961 by newly developed extraction methods applicable to inorganic core samples.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

7.0055, MARINE GEOCHEMISTRY RESEARCH

E.D. GOLDBERG, Univ. of California, Graduate School, *San Diego - La Jolla*, *California* 92038 (AT(11-1)-34-84)

1. Determination of solubilities of neon, krypton and xenon as a function of temperature and salinity of seawaters to utilize in our field analyses interpretations. We have measured all of the noble gases in seawaters from the world oceans and have concluded that the noble gases are generally not in concentrations expected from thermodynamic equilibrium but are altered by physical processes. Better solubility values will allow a more rigorous evaluation of our results, the mass spectrometric determinations in sea water. 2 Geochemistry of fluorine through studies of its concentration in materials involved in the major sedimentary cycle. The analytical method, involving the photoactivation of fluorine in a linear accelerator, allows analyses to be made down to the 10 p.p.m. range. Our initial results have indicated a concentration in calcium carbonates precipitating from the ocean to levels of 1000 p.p.m. in corals. The chemical behavior of this element in nature is being illuminated by this work and our present studies indicate involvement in mineral formation where calcium ions precipitate or where micas are formed. 3. Developments of new geochronologies for the marine sedimentary record. The high values of thorium (100 ppm) in barites may allow Th/He dating of these minerals.

Results to Date: 1. The analyses of the rare gases helium, neon, argon, krypton and xenon in depth profiles obtained from the Pacific, Atlantic and Antarctic oceans show departures from thermydoyamic equilibrium. Methods of analyses is mass spectrometric. 2. Development of geochronological techniques for the marine sedimentary column: uranium/ionium; ionium/thorium; uranium-234/uranium 238; beryllium-10; potassium argon. 3. Formation of ferromanganese nodules. Minor element composition of the ferromanganese minerals is controlled by the mineralogy and the formation of the mineral phases is depth dependent.

SUPPORTED BY U.S. Atomic Energy Commission

7.0056, ALTERATION OF MINERALS

M.N. PETERSON, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla*, *California* 92038 (NONR)

The objective is to investigate the origin and alteration of minerals in the sea as major processes in determining the composition of sea water and marine sediments. The approach is to expose geologically significant materials either to natural water bodies on long-life moorings, or to approximations of natural solutions under laboratory conditions. Measurements are planned on aragonite, amorphous silica, and certain phosphates and sulfates.

This research will contribute to an understanding of the geographic distribution of these minerals in the deep-ocean sediments. In addition, the results of this study will allow constraints to be placed on the use of inexpensive construction materials, such as concrete, in the deep ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0057, GEOCHEMICAL STUDIES OF DEEP-SEA DEPOSITS - THEIR SOURCES AND MODES OF DEPOSITION

K.K. TUREKIAN, Yale University, Graduate School, *New Haven*, *Connecticut* 06520

During the past eight years significant advances have been made in the study of the geochemistry and mineralogy of deep-sea sediments premarily in the Atlantic Ocean. With a thorough and sound framework it is proposed to bring these studies to fruition by concentrating on the processes that might be responsible for the observed patterns. This calls for work on strontium isotope studies in ancient deep-sea sediments, and weathering profiles; the composition of planktonic calcareous organisms found in tows; the variations of trace element composition of detrital material carried by streams; and systematic statistical analysis of the large amount of data on deep-sea sediments to extract additional information on regional effects in trace element (including Mn and Fe) distribution.

SUPPORTED BY U.S. National Science Foundation

7.0058, A STUDY OF THE LEAD OXYCHLORIDES AND RELATED SPECIES FOUND IN THE ANCIENT SLAGS OF LAURIUM, GREECE

P.E. DESAUTELS, Smithsonian Institution, *Washington, District of Columbia* 20560

The action of sea water on the ancient slags from the silver mines at Laurium, Greece has created a series of interesting compounds through the centuries. Two of these species were discovered in the slags before being found in natural deposits.

This slag suite has never been studied adequately as a related group and the few species described are not well done. It is also obvious that several other species are present but not described.

A large quantity of material is on hand and will be systematically examined. X-ray and other standard mineralogical techniques will be used.

SUPPORTED BY Smithsonian Institution

7.0059, ROCKS OF OCEANIC CRUST AND UPPER MANTLE EQUATORIAL ATLANTIC

W.G. MELSON, Smithsonian Institution, *Washington, District of Columbia* 20560

This investigation is part of program concerning the nature, origin, and development of the suboceanic mantle and deeper layers of the oceanic crust. This particular project concerns rocks dredged from the Mid-Atlantic Ridge in the equatorial Atlantic, and from the Romanche Trench. Determinations of mineralogy, bulk chemical composition, and petrography provide the basic data in this project. This investigation will also include experimental work on the probable stability fields of low grade metamorphic assemblages derived from basalts and peridotites, two common oceanic rocks.

SUPPORTED BY Smithsonian Institution

7.0060, CONTRACT FOR-PROCESSING OF USARP ROCK SAMPLES

T.E. SIMKIN, Smithsonian Institution, *Washington, District of Columbia* 20560

Since the beginning of the U.S. antarctic program, huge collections of rocks have been brought back to the United States by field collectors, and the volume of unstudied specimens increases significantly with each passing year. One major source of the continuous influx of new specimens is the Eltanin operations, during which large numbers of unconsigned rocks are collected by bottom trawling. At the same time, geologists have expressed the desire to obtain samples of specific groups of antarctic rocks, but most often have been unable to do so unless they do the collecting themselves. Similar situations prevailed in other fields until sorting and distribution centers were established at the Smithsonian Institution (biology) and Florida State University (sediments).

This project at the Smithsonian Oceanographic Sorting Center (SOSC) provides for the preliminary identification, inventorying, and distribution to specialists of antarctic rock samples under procedures similar to those governing the processing of biological specimens by SOSC. The identification will start with megascopic work and include petrology of thin-sections of appropriate specimens. Inventorying will be closely tied to the data system for USARP specimens already in operation at SOSC (NSF Contract C-494). It is expected that most of the effort under this contract will be devoted to ocean-bottom rocks.

SUPPORTED BY U.S. National Science Foundation

7.0061, ROCKS OF THE OCEANIC CRUST

T.E. SIMKIN, Smithsonian Institution, *Washington, District of Columbia* 20560

Petrological studies of rocks from the ocean floor. Use of data to draw conclusions with regard to the evolution of the ocean basins.

SUPPORTED BY Smithsonian Institution

7.0062, RESEARCH ON MINERAL STRUCTURE REVEALED BY AN ELECTRON MICROSCOPE

K.M. TOWE, Smithsonian Institution, *Washington, District of Columbia* 20560

Uses an electron microscope to carry on research on mineral specimens and skeletal structures of biological organisms from the ocean.

SUPPORTED BY Smithsonian Institution

7.0063, CLAY CHEMISTRY

D. CARROLL, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

A study of the nature and identity of clays in the marine environment, and their alteration.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0064, PETROLOGY AND GEOCHEMISTRY OF IGNEOUS ROCKS FROM THE OCEAN FLOOR

E. BONATTI, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

Igneous rocks form the backbone of mid-oceanic ridges and are present in other regions of the sea floor below a layer of sediments. Collections of rocks were obtained in recent cruises of the Institute of Marine Sciences from the East Pacific Rise and the Equatorial portion of the Mid-Atlantic Ridge, as well as from sea mounts located at various distances from the ridges. The rocks recovered from the Pacific are mainly tholeiitic basalts while those from the Atlantic include peridotites and serpentinites, gabbros and basalt. Ultramafics appear to be dominant in the deeper part of tectonic fractures which displace the Ridge. A detailed petrographic and chemical study of these samples and others to be collected in forthcoming cruises will be made. Optical microscopy, X-ray diffraction, and electron microprobe will be employed for the mineralogy; X-ray fluorescence, optical spectroscopy, atomic adsorption, neutron activation, istope dilution as well as classical gravimetric and colorimetric methods will be employed for the chemistry. In addition to the major oxides, elements will be determined: particularly, the transition metals, the rare earths; U, Th, Rb, Sr, and Sr 87/Sr 86. K/Ar age determinations will be carried out in all suitable samples

SUPPORTED BY U.S. National Science Foundation

7.0065, NEUTRON ACTIVATION ANALYSIS OF IRON METEORITES

D.E. FISHER, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

Work will be continued on the nuclear analysis of meteorites and related materials. Studies on the K/Ar ages of iron meteorites will be continued, Al abundances in pelagic samples will be determined, and chemical analysis of microtektites will be carried out, all using activation analyses. Cosmogenic C-14 in stone meteorites and cosmogenic Al-26, K-40, and Co-60 in iron meteorites will be analyzed. Fission track determinations on crystals abstracted from meteorites will be hopefully carried out.

SUPPORTED BY U.S. Atomic Energy Commission

7.0066, POTASSIUM/ARGON DATING OF DEEP-SEA SAMPLES

D.E. FISHER, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

The purpose of this program is the dating of marine rocks and sediments by the K/Ar method, combining this work with other experiments currently in progress. First, the reliability of the K/Ar method for dating marine samples will be rigorously investigated. When particular mineral phases have been judged to be acceptable for dating, the technique will be applied to the following problems: 1) the dating of sediments in which low-level gamma-emitting radionuclides will have been measured, in an attempt to trace back through time the infall rate of extra-terrestrial dust and the history of the solar proton flux; 2) the K/Ar dating will be combined with geochemical, mineralogical and micropaleontological studies of pre-Pleistocene sediments to extend back through the Tertiary the chronology for the variations in time of the parameters already analyzed for the Pleistocene; 3) rocks dredged from the ocean floor in specific relation to the mid-ocean rises will be K/Ar dated to critically test the hypothesis of spreading ocean floors.

SUPPORTED BY U.S. National Science Foundation

7.0067, THE MARINE GEOLOGY OF THE SOUTHERN OCEAN

H.G. GOODELL, Florida State University, Graduate School, *Tallahassee, Florida* 32306

Florida State University will continue to assist in the collection of rock material and sediment cores from the Antarctic region aboard the USNS Eltanin. Geologists at FSU will be responsible for processing the cores, their storage and sampling, and the distribution of samples to research scientists. Individual research projects based on the core and dredge samples at the Antarctic Core Facility are underway for each of the geologists and graduate students supported under that project. These include investigations into: 1) geochemistry and mineralogy of surface sediments, 2) geochemistry and petrology of indigenous volcanics, 3) paleosediment distribution at the Brunhes Matuyama boundary, 4) stratigraphy and ecology of coccoliths, 5) ice- rafted sediments and Antarctic glaciation, 6) geochemistry of manganese nodules, 7) radioisotope geochemistry of carbonate and noncarbonate sediments, 8) thermoluminescence of carbonate oozes, 9) radioisotope geochemistry of surface sediments, 10) mineralogy and geochemistry of zeolites in sediments and volcanics.

SUPPORTED BY U.S. National Science Foundation

7.0068, STUDIES IN MARINE CHEMISTRY

R.C. HARRISS, Florida State University, Graduate School, *Tallahassee, Florida* 32306

1. Chemistry and mineralogy of marine vertebrate bone mineral - A study of factors controlling the ratio of amorphous to crystalline material and trace element uptake in bone mineral of marine fishes. Project duration 6/68 - 6/70.

2. Effect of trace elements on crystal structure and solubility of bone mineral - Hydroxylapatite is precipitated in laboratory experiments at various levels of flouride, magnesium, and pesticide concentrations. X-ray diffraction and electron microscopy are used to determine the effect of coprecipitated trace constituents on the lattice parameters and crystal size of hydroxylapatite. Project duration 6/68-6/71.

3. Marine geochemistry of some precious metals - The sources and distribution of Pd, Ir, and Au in deep sea sediments and manganese nodules is being investigated using neutron activation analysis. Project duration 1/67 - 6/70.

4. Atmospheric chemistry of boron and fluoride - Specific ion electrode techniques are being developed to investigate the loss of boron and fluoride across the sea-air interface and the subsequent distribution of these elements in the atmosphere. Consideration is also being given to problems related to atmospheric pollution.

SUPPORTED BY Amer. Chemical Society
National Research Council of Canada

7.0069, GEOCHEMISTRY OF CARBONATE CYCLE IN THE MARINE ENVIRONMENT

K.E. CHAVE, Univ. of Hawaii, Graduate School, *Honolulu, Hawaii* 96822 (N00014-67-A-0387-0002)

Calcium carbonate in the surface layers of seawater tends to precipitate out spontaneously in orifices of various kinds, altering the flow patterns and affecting naval machinery. In addition, calcium carbonate particles affect light scattering and acoustical attenuation and scattering. This research is investigating the processes of carbonate precipitation and, in particular, the effect of organic chemicals in seawater on the precipitation, dissolution, dispersal and deposition of these carbonate particles.

The research involves a survey of suspended minerals in seawater in the South Atlantic and Caribbean and in the Hawaiian and Line Island areas of the Pacific using research vessels for the collection of samples; laboratory studies of the chemical interactions between carbonate minerals and surface active organic molecules; and a study of production, dispersal and deposition of carbonate minerals in the cold waters off the California Coast.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0070, MARINE HYDROLOGY AND GEOCHEMISTRY, ATLANTIC CONTINENTAL SHELF AND SLOPE

R.H. MEADE, U.S. Dept. of Interior, Water Resources Division, *Woods Hole, Massachusetts*

Objectives: (1) To determine the rates and loci of fresh water (both surface and ground waters) and salt water along the Atlantic Coast, and to understand the influences of different factors on mixing processes. (2) To determine the chemical compositions of surficial sediments and older sedimentary rocks of the Atlantic Continental Shelf and Slope -- including the composition of their interstitial waters -- and to understand their areal and stratigraphic variations. (3) To determine the amount of suspended matter and to understand the dispersal of sediments in coastal waters.

Approaches: (1) Information on salinity (the main index of mixing of fresh and salt waters) and its variations in coastal waters is being compiled in atlas form, largely from existing data. (2) Chemical analyses (major and selected minor elements) are being made of surficial bottom sediments from the continental shelf and slope, and of rocks and interstitial waters that lie below the shelf and slope. Concentrations of suspended matter have been measured gravimetrically, and suspended constituents have been identified microscopically.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0071, GEOCHEMISTRY OF MID-ATLANTIC RIDGE SEDIMENTS

J.L. BISCHOFF, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

The purpose of this investigation is to study the mineralogy, interstitial water chemistry, and geochronology of series of closely spaced cores to be taken during the summer of 1968 in conjunction with a geophysical and paleontological survey of the mid-Atlantic ridge, primarily in the area from 35 degrees to 45 degrees North. Review of previous work indicates many gaps, particularly regarding detailed work, in the correlation of data from the above fields of study

SUPPORTED BY U.S. National Science Foundation

7.0072, RADIOELEMENT STUDIES IN THE OCEANS - GEOLOGY AND GEOCHEMISTRY ABOUT THE MID-ATLANTIC RIDGE

V.T. BOWEN, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (AT(30-1))

To increse our understanding of the processes removing radioelements to the sediments, and producing special sediment conditions for such removal, as well as to improve our knowledge of the significance of bottom sources of supply to element geochemical cycles we have undertaken, often on samples collected for other purposes, studies of the geochemistry of the mid-Atlantic Province.

SUPPORTED BY U.S. Atomic Energy Commission

7. MARINE GEOLOGY

7.0073, ANALYSES OF ROCKS COLLECTED IN THE INDIAN AND ATLANTIC OCEANS

R.L. CHASE, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

The main objective of this study is to analyze igneous, sedimentary and metamorphic rocks dredged from the Indian Ocean during the IIOE as well as from the Puerto Rico Trench, the Barracuda Scarp, the Mid- Atlantic Ridge and the Mediterranean Sea. Petrologic, chemical, magnetic, x-ray and isotopic analysis will be performed on the samples. This will be evaluated with regard to seismic, magnetic, gravity and paleontological evidence to further define the composition, structure and history of the oceanic crust.

SUPPORTED BY U.S. National Science Foundation

7.0074, BIOGEOCHEMISTRY OF TERRESTRIAL & EXTRATERRESTRIAL ORGANIC MATTER

E.T. DEGENS, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

Objective: Purpose: To determine the diogenetic fate of organic matter in marine sediments. To synthesize primordial proteins on clays containing heavy metal ions. To determine the biochemistry (amino acid and purine/pyrimidine composition) of microorganisms in exotic environments.

Application: Origin of life; formation of oil.

Approach: The changes in fossil organic matter are followed by modern chemical analytical techniques.

Progress: October 1965 - April 1966. A rapid method for analysis of purines and pyrimidines in sediments has been developed. The biochemistry of some sulfur reducing bacteria that live at 90 degrees C (approximately) showed the presence of hypoxanthine in place of adenine in DNA.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

7.0075, ISOTOPIC AND TRACE ELEMENT STUDIES IN OCEANIC VOLCANIC ROCKS

P.W. GAST, Columbia University, Graduate School, *Palisades, New York* 10964

A program of combined trace element studies (Rare Earth Elements, alkali metals and U, Th, and Pb and isotope studies (Pb and Sr) in several volcanic areas in the Atlantic is proposed. The specific objectives of this study are: 1. To characterize the source or sources of volcanic liquids in a given region with respect to their Pb and Sr isotope composition. 2. To relate the source isotope compositions to U/Pb ratios of observed magmas. 3. To relate variations in Rare Earth Elements ragios, U/Pb, Th/U, K/Rb and Ra 226/U ratios to degree of partial melting and fractional crystallization that are involved in magma forming and transport processes.

SUPPORTED BY U.S. National Science Foundation

7.0076, URANIUM GEOCHEMISTRY IN (MODERN) CARBONATES USING THE FISSION TRACK METHOD

G.M. FRIEDMAN, Rensselaer Polytechnic Inst. , Graduate School, *Troy, New York* 12181

The purpose of the proposed research is to define the geochemical relationships between uranium and carbonate material from a spectrum of carbonate depositional environments. Sample suites consist of sediments and carbonate hard parts of living organisms from hypersaline, marine, brackish, and fresh water environments, and land dwelling organisms. The results of uranium analyses will be examined with respect to environment, mineralogy, stable isotope data, and other available trace element data. The effect of carbonate diagenesis on uranium content and distribution will be examined on samples of known history. Water samples from the above environments will be analyzed in order to relate uranium content of environment to uranium content of carbonate material.

All uranium analyses will be obtained by routine fission track techniques. The carbonate mineralogy will be determined by conventional X-ray methods.

SUPPORTED BY U.S. Atomic Energy Commission

7.0077, SEDIMENT MINERALOGY (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)

D.A. WOLFE, U.S. Dept. of Interior, Radiobiological Lab. , *Beaufort, North Carolina* 28516

Sediments have the capacity to scavenge many radionuclides from sea water. There is, however, little agreement as to the effect of this phenomenon on the food web of the sea. Will this scavenging action enhance or reduce the uptake of radioactivity by the biota? If organisms have the capacity to utilize the organic matter in sediments as a source of nourishment, sediment-sorbed activity could be passed along the food web to eventually reach man. Conversely, by adsorbing radioactive materials from sea water, sediments could reduce the possibility of contamination in many pelagic animals.

In order to determine the role of sediments in the cycling of radionuclides in the estuarine environment and to gain some insight into sediment-animal relationships, experiments on sediemnt-sorption of radionuclides are being carried out in the laboratory and in the field. Observations are made on the capacity of natural sediemnts and selected clay minerals such as montmorillonite, to scavenge radionuclides (zinc-65, cesium-127, and chromium-51) from sea water of varying salinity. Also, the partition of these radionuclides between the sediments, and biota of outdoor ponds will be studied.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

7.0078, RELATIONSHIPS BETWEEN PHOSPHATE AND OTHER CHEMICALS AT THE WATERSUBSTRATE INTERFACE IN WESTERN LAKE ERIE

N.W. BRITT, Ohio State University, Graduate School, *Columbus, Ohio* 43210

This project is designed to determine the chemical and physical relationships between the water and sediment in western Lake Erie. Little is known about the seasonal or longterm changes which have occurred or are occurring at various depths in the sediment and the overlying water. The specific areas of investigation include chemical determinations of the total phosphate, organic content, iron, sulfate, and arsenic content of the sediment and overlying water throughout the year.

Determination of the physical composition of the sediment may give an indication of the rate and amount of siltation. Redox potential and pH determinations should give an indication of some of the chemical changes occurring in the sediments and overlying water.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
Ohio State University

7.0079, CARBON ISOTOPE GEOTHERMOMETRY

W.M. SACKETT, Univ. of Tulsa, Graduate School, *Tulsa, Oklahoma* 74104

The isotopic composition of the organic carbon in a suite of oceanic plankton samples has shown an apparent temperature dependence. Substantiation of this dependence may lead to another isotope paleotemperature tool for marine sediments.

Development of the carbon isotope geothermometer will be attempted through detailed isotopic analyses of additional plankton samples, controlled growth of unicellular green algae at different temperature and comparison of the isotopic organic carbon composition of selected intervals of cores of deep-sea sediments with other paleo-temperature interpretations.

SUPPORTED BY U.S. National Science Foundation

7.0080, AGE RELATIONS OF IGNEOUS ROCKS FROM THE MID-ATLANTIC RIDGE

J.B. CORLISS, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

The project has evolved into a study of rare earth and other trace element distributions in basalts and greenschists from selected portions of the Mid-Atlantic Ridge for which detailed morphological and structural information exists. The elemental abundances are determined by instrumental activation analysis. These results and the associated petrology of the rocks are to be integrated with other knowledge to gain insight into (1) variations in upper mantle composition beneath the ridge, (2) genetic relations between common rock types of the Ridge, and (3) effects of the alteration of the rocks on the sea floor.

SUPPORTED BY Amer. Chemical Society

7.0081, RARE GAS STUDY OF INTERPLANETARY MATERIAL IN PELAGIC SEDIMENTS

D. TILLES, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

A study of the amounts and isotopic ratios of rare gases in mineral concentrates from pelagic sediments will be conducted. Fractions which may contain detectable amounts of extraterrestrial components will be isolated via mineralogical separations. Mass spectrometric measurements of anomalous rare gas amounts and isotope ratios will be made in gas released at successively higher temperatures. Rare gas anomalies, already observed in gas released from concentrates of pelagic sediments and particulates from polar ice, give great promise of being unambigous indicators of an extraterrestrial origin. An ultra-high vacuum mass spectrometer with low-background and high sensitivity is essential to the study. Also required and included in the equipment requested are necessary components for a rare gas extraction, purification, and separation system, as well as specialized mineral concentration equipment for separating pelagic sediments. The program will combine mineral and grain size separation and rare gas mass spectrometry with X-ray diffraction and chemical analyses to attempt to learn as much as possible about the anomalous rare gas bearing phases in sea sediments.

SUPPORTED BY U.S. National Science Foundation

7.0082, NUCLEAR CHEMISTRY AND GEOCHEMISTRY RESEARCH

T.P. KOHMAN, Carnegie Mellon University, School of Engineering, *Pittsburgh, Pennsylvania* 15213

Mossbauer spectrometric studies of natural iron-containing materials (coal, minerals, rocks, meteorites, tektites), to determine the distribution and chemical form of iron in these materials, will be continued and may be extended to other elements.

Rates of nuclear reactions produced by negative muons from accelerators and the cosmic radiation will be investigated through measurement of induced radioactivity, and dating methods based on these reactions will be investigated.

In work on dating of climate-correlated deep-sea sediments, attempts will be made to apply simultaneously or complementarily a variety of dating methods to the same core: C14, Pa231 plus Th230 plus U234, Al26 plus Be10, and fission tracks in volcanic glass and authigenic minerals.

Measurement of natural I129 in terrestrial materials by activation analysis will be continued, and may be extended to stone meteorites, in order to obtain information about the past history of the terrestrial and cosmic environments.

The content and distribution in various types and phases of meteorites of Hg, Tl, Pb, and Bi will be determined by slow- and fast- neutron activation analysis, to provide information on the early history of the solar system.

The search for extinct natural radioactivity of Pb205 through thallium isotope studies in meteorites will be continued, and similar work on Pd107 and Sm146 may be undertaken. Preparations will be made for similar studies of lunar materials.

Cosmic-ray-produced radionuclides in iron meteorites, especially Be10, C14, Al26, Cl36, Ar39, Mn53, and Ni59, will be measured to determine the variations with depth and meteoroid size, and the results compared with calculations based on radiochemical studies of nuclear reactions produced by accelerator beams in thick targets.

Search for natural beta activity of Ca48 by the active-daughter- extraction method will be continued and possibly extended to Zr96.

SUPPORTED BY U.S. Atomic Energy Commission

7.0083, IGNEOUS AND SEDIMENTARY ROCKS FROM THE NORTH WALL OF THE PUERTO RICO TRENCH

A.J. NALWALK, Univ. of Pittsburgh, Graduate School, *Pittsburgh, Pennsylvania* 15213

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

7.0084, ISOTOPIC AND CHEMICAL COMPOSITION OF ORGANIC CARBONATES

M.L. KEITH, Penn. State University, Graduate School, *University Park, Pennsylvania* 16802

It is proposed to investigate the variability and specific ranges of carbon and oxygen isotopic composition, and possible relationships to chemical composition of modern organic carbonates, with particular emphasis on suites of samples from marine biologic communities. A principal objective is to develop an understanding of characteristic compositional variations which can be attributed to vital effects of carbonate-secreting organisms. Accordingly, it is proposed to expand the current investigation of coral and algal carbonates to encompass other organic carbonates which vary widely in isotopic or elemental composition or which differ in composition from one taxonomic group to another. It is hoped that systematic data on composition and ecology will provide an improved basis for interpreting the genesis of limestones.

It is proposed to investigate the variability of isotopic and elemental composition of organic carbonates by systematic analysis of the carbonates of co-habitant organisms, and to examine and interpret the relationships among isotopic and chemical parameters. Proposed stages of investigation include: (1) Chemical analysis of Jamaican reef samples on hand, mainly coral and algal carbonates, whose isotopic composition has already been measured. Some of these show systematic relationships between C13 and O18, as yet unexplained; (2) Collection and analysis of additional specimens from the Jamaican reefs, including asteroids, barnacles, crinoids, crustaceans, echninoids, and foraminifera, as well as additional specimens of calcareous algae; (3) Systematic study of organic carbonates from one or possibly two additional reef communities, for comparison with the Jamaican reef carbonates.

SUPPORTED BY U.S. National Science Foundation

7.0085, STABLE ISOTOPE FRACTIONATION IN ECHINODERM CALCITE

J.N. WEBER, Penn. State University, Graduate School, *University Park, Pennsylvania* 16802

A recently reported study of the carbon and oxygen isotopic composition of calcite deposited by echinods (sea urchins and sand dollars) has shown that these marine organisms fractionate carbon and oxygen isotopes up to as much as 13 permil with respect to the calcium carbonate secreted by other animals such as molluscs under the same ambient conditions. Isotope fractionation was demonstrated to be largely genetically controlled and the influence of environmental conditions was shown to be relatively unimportant. A striking correlation between isotopic composition and taxonomy was evident, and the calcite from each of the 260 individuals from polar to tropical seas and from littoral to abyssal depths was clearly not in isotopic equilibrium with the seawater environment.

The proposed work would include analyses of recent sea urchins, namely the starfish, brittle stars, crenoids, and sea-cucumbers. Preliminary analyses have shown that calcites of these echinoderms are out of isotopic equilibrium with the external environment. One of the most important elements of this research will be to determine the mechanism involving the carbon and oxygen isotope fractionation by echinoderms. This will include studies of the variations in the amino acids, and kinetic isotope fractionation during decarboxylation as a function of metabolism rate. It is also proposed to compare isotopic distribution patterns in recent fossils. It is anticipated that the above studies should provide a new approach to echinoderm phylogeny using fossil skeletons as indices.

SUPPORTED BY U.S. National Science Foundation

7. MARINE GEOLOGY

7.0086, TRACE ELEMENT AND STABLE ISOTOPE STUDIES OF CORAL REEF CARBONATES

J.N. WEBER, Penn. State University, Graduate School, *University Park, Pennsylvania* 16802

This proposal is a continuation of NSF grant GA-290, and it is concerned with the distribution of trace elements and stable isotopes in coral reef carbonates. The main objective is to determine the past environmental conditions that existed when the ancient reefs were formed in the geologic column.

(1) It is proposed to determine the extent of carbon and oxygen stable isotope fractionation during calcification of the major carbonate contributing marine invertebrates.

(2) To determine trace and minor element distributions within the marine invertebrates.

(3) To understand the development and distribution of ancient reefs, and to understand the effects of diagenesis, tending to alter the chemical and/or isotopic composition of these reefs.

SUPPORTED BY U.S. National Science Foundation

7.0087, RADIOCARBON DATING OF A HAWAIIAN REEF PROFILE

E.A. OLSON, Whitworth College, Graduate School, *Spokane, Washington* 99218

The objective of this proposal is to elucidate the pattern and chronology of reef development in Hanauma Bay, Oahu, Hawaii through radiocarbon dating of four cores. For each of the four reef cores obtained, age measurements will be made of top and bottom material plus four samples spaced throughout each core. It is hoped to establish 1) the age of the reef, 2) the rate of rise of sea level during perhaps the past 10,000 years, 3) the rate of vertical and horizontal growth, and 4) the consistency of the C14 method in dating coral reefs.

SUPPORTED BY U.S. National Science Foundation

7D. GEOPHYSICS - STRUCTURAL GEOLOGY

(origin and Evolution of Ocean Basin Structures; Geophysical Studiesof Oceans; Seismic Propagation.)

7.0088, STUDIES OF EARTHQUAKES IN THE CAPE MENDOCINE AREA

B.A. BOLT, Univ. of California, Graduate School, *Berkeley, California* 94720

This is a new task in partial support of telemetering local earthquakes recorded at two stations in northern California (Arcata and Mineral) to the main station at Berkeley, California, and in support of studies on earthquakes originating at sea near Cape Mendocino, California. Telemetering earthquake recordings at the Arcata and Mineral stations to the Berkely station will permit more rapid and accurate determinations of earthquake origins and epicenters in the area off the coast of Cape Mendocino than is now possible with the existing station network tied in to Berkely.

More earthquakes occur off the coast of Cape Mendocino than anywhere within California. These quakes are sometimes large enough to cause damage to harbor facilities and such naval installations as underwater cables. It is of interest to know about the occurrences of these earthquakes, particularly their epicenters and magnitudes, to determine whether they could have been the cause of observed damage. Telemetering data from Arcata and Mineral will increase the accuracy of presently located epicenters and origin times in this region.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0089, INELASTIC SEISMIC EFFECTS

P. LIEBER, Univ. of California, School of Engineering, *Berkeley, California* 94720 (N00014-67-A-0114-0003)

This research is directed towards determining the effects of earth inelasticity on seismic surface wave propagation and on earthquake mechanisms. The disperson, selective absorption, and attenuation of seismic Love waves propagating in an inelastic model of the earth's crust and mantle are being quantitatively evaluated and compared with observed seismic surface-wave data. The comparison will then serve as a basis for refining the inelastic parameters used in the earth model.

The propagation of acoustic waves through the ocean and underlying rocks is important in certain Naval operations. This program should help provide a basic understanding of these propagation properties. In addition, the analytical capabilities being developed in this program may prove useful in studying hydrodynamic processes which, although acting deep within the earth, have a strong influence on surface features and properties.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0090, CONTINUITY OF CLIPPERTON AND CLARION FRACTURE ZONES

M.N. BASS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

A continous reflection profile along 91 degree W longitude failed to confirm the continuity of structure between Clipperton fracture zone and the Santa Elena Peninsula, Costa Rica, which is suggested by the geology and structural trends and which has been proposed by other investigators. This raises a more general question about the continuity of fracture zones, particularly those like Clarion and Clipperton, whose topographic expression is, as now known, sporadic. It is proposed to run about ten reflection and gravity profiles across those segments of Clarion and Clipperton in which local topographic relief is subdued or wanting.

SUPPORTED BY U.S. National Science Foundation

7.0091, REFLECTION PROFILING OF THE SEA FLOOR

J.R. CURRAY, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

This amendment is for supplemental funds and time to make it possible for completion of specific research projects already in progress. These projects include reflection profiling of the floor of the Pacific Ocean, continued studies of the continental margin off Western North America, studies of coral atolls in the southwest Pacific, and investigations of different parts of the Clipperton and Clarion Fracture zones.

SUPPORTED BY U.S. National Science Foundation

7.0092, STRUCTURE OF OCEAN BASINS

R.L. FISHER, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (NONR)

The objective is to interpret the topography and structure of the deep ocean floor in terms of the controlling processes. For several years, attention has been concentrated on the southwest Pacific and the Indian Ocean. This work entails preparation of very detailed bathymetric charts based on all available data and on new soundings made for the purpose. During the coming year, two segments of the Mid-Indian Ocean Ridge will be explored by geophysical and geological methods. Observations and samples made during 1967 on expedition NOVA will be analyzed.

Operations which utilize underwater sound are strongly dependent upon the physiography of the ocean bottom and upon the acoustic properties of the sediments in the areas of operation. In addition, naval operations such as magnetic navigation, can be made more effective if prior knowledge of the earth's magnetic field is available. This program will help provide not only basic bathymetric and magnetic data, but also a predictive capability for extending this information into unsurveyed areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0093, ROCK SAMPLING AND GEOPHYSICAL STUDIES IN THE TONGA KERMADEC TRENCH SOUTHWEST PACIFIC

R.L. FISHER, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

This proposal is primarily to cover acquisition of a camera system to photograph the bottom and sides of the Tonga-Kermadec Trench prior to dredging these areas. Localities for photography and dredging will be based on reflection profiling carried out during a major expedition to the Southwest Pacific during April - December 1967.

SUPPORTED BY U.S. National Science Foundation

7.0094, STUDY OF EARTH NOISE ON LAND AND SEA BOTTOM

F. GILBERT, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

Objective: This investigation is aimed at a description and understanding of the seismic background noise on land and the sea bottom. The research will investigate the use of large land arrays and ocean bottom seismographs to observe and record earthquakes explosions and seismic noise in wave number space. That portion of the program involving land arrays will utilize the Vela Uniform Programs, Tonto Forest Seismological Observatory at Payson, Arizona, to investigate the partition of energy in leaky and trapped modes in the continental wave, guide the scattering of energy between trapped and leaky modes and dissipation of seismic energy as a function of frequency and wave number and attempt to cross-correlate between the acoustic and seismic signals at ultra-low frequencies (1 to 3 cycles). The ocean bottom portion of this research will continue to use and further develop the ocean bottom seismograph system developed earlier in this program. In close conjunction with the land work definitive measurements of the propagation of seismic signals across the land ocean boundary will be made and thus study the transition zone which couples the oceanic wave guide to the continental guide.

SUPPORTED BY U.S. Dept. of Defense - Air Force

7.0095, DEEP OCEAN AS RECIPIENT OF VOLATILES AND SOLUTES

J.S. HANOR, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

A detailed study will be made within a selected area in the East Central Pacific of the lateral and stratigraphic distribution of barium, manganese, iron and other elements indicative of hydrothermal activity. The purposes of this study are: 1) to locate and identify specific loci for the hydrothermal injection. 2) to determine whether there have been fluctuations in the intensity and extent of hydrothermal mineralization with time, and if so, to determine if these correlate with known periods of tectonism, volcanism, and mineralization on the continents. 3) to ascertain whether the distribution is consistent with ocean floor spreading from the East Pacific Rise.

SUPPORTED BY U.S. National Science Foundation

7.0096, RECENTLY PRECIPITATED DOLOMITES AND ASSOCIATED MINERALS

M.N. PETERSON, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

Rates of crystal growth and sequences of formation of phases, of dolomite and associated Ca-Mg carbonates, with added emphasis on the formation of authigenic silicates, including clay minerals and inorganic chart.

SUPPORTED BY Amer. Chemical Society

7.0097, MOHOLE SITE STUDIES

G.G. SHOR, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The National Academy of Sciences Site Selection Committee, Advisory to the Mohole Project, recommended in September 1965 that detailed seismic surveying along the Hawaiian Arch in the vicinity of the Mohole site northeast of Maui is necessary prior to making further plans. It was also recommended that further reconnaissance geophysical surveying along the arch be conducted.

The problems connected with the Hawaiian Arch that need to be solved prior to mantle drilling in 1968 are: 1. to the mantle at the present site is required. 2. The possibility of even shallower sites along the Arch needs to be investigated. 3. The possibility of seismic anistropy at the site needs to be solved. There is much indication that mantle seismic velocities may vary with azimuth. If so, depth calculations to the mantle could be affected. This possibility is slight but it requires checking. 4. Sediment cores from the Hawaiian site and along the Arch are required for bearing strength determinations. A 65,000 - 75,000 pound landing base must be supported on the bottom during drilling. The shear strength of the sediments must be determined so that the landing base can be designed. 5. Gravity and magnetic observations need to be extended in the area both for background information and as a guide for seismic surveying.

The University of California at San Diego, Scripps Institution of Oceanography, will conduct the surveys in cooperation with the Universities of Hawaii and Wisconsin, to accomplish these objectives. Oregon State University has also agreed to provide a vessel, the R/V YAQUINA.

SUPPORTED BY U.S. National Science Foundation

7.0098, GRAVITY FIELD AT SEA

P.M. SPIESS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (NONR)

This research is directed toward the measurements of the earth's gravity field over the oceans and the investigation and interpretation of the anomalous variations which we observed. During the coming year, gravity data taken on the recent NOVA expedition to the Southwest Pacific will be reduced and analyzed.

The accuracy of inertial navigation systems which are used extensively by the Navy is presently limited by insufficient knowledge about the earth's gravity field and deflections of the vertical. In support of efforts to remove this limitation, this program is (1) providing gravity data over the world's oceans and (2) contributing to the basic understanding of gravity variations which is necessary for the prediction of deflections of the vertical.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0099, DETECTION OF DEEP-SEATED ANOMALIES IN ELECTRICAL CONDUCTIVITY UNDER THE GULF OF CALIFORNIA

V. VACQUIER, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

It is thought that the Gulf of California is part of the world ridge-rift system which intersects the North American continent via the East Pacific Rise and, as a consequence, may be an example of the earliest stage of continental drift. In searching for a plausible mechanism explaining the East Pacific Rise and the splitting of the Gulf of California--the high heat flow in both areas suggests that the ultimate source of energy is thermal. This proposal presents a program to investigate the depth of these sources of thermal energy beneath the Gulf of California. Magnetic time variations in three components will be measured across the Gulf of California making use of islands for station sites. The analysis of these variations should determine whether or not the Gulf is a rift caused by the rise of hot mantle material. A similar study made across the Rio Grande rift belt demonstrated a correlation between surface heat measurements and the geomagnetic time variations, and forms the basis for the present proposal. The personnel manning the astrometric observatory sites (GP-4639) will be used to man some of the three component magnetometer stations.

SUPPORTED BY U.S. National Science Foundation

7.0100, HEAT FLOW MEASUREMENTS

V. VACQUIER, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

It is proposed to investigate the heat flow of the previously unstudied areas of the Melanesian subcontinent and of the Philippine Basin. The latter area will be investigated by S. Uyeda and his colleagues of the University of Tokyo under the U.S. Science Program. The measurements in the Melanesian subcontinent should determine whether or not this region is at the intersection of an ocean basin and a highly faulted oceanic rise. Following this is a proposed comparison of heat flow measurements and magnetic time variations across areas of known high heat flow off the coast of Central America. While detailed heat flow measurements investigate the size and depth to the near-surface igneous activity and analysis of the magnetic time variations should determine the spatial distribution of the source of this activity. It is also intended to study the significant difference discovered, during the AETES 1966 cruise of R/V ARGO, between the in situ method and the normal indirect on-deck methods of measuring thermal conductivities of ocean bottom sediments. Finally, it is planned to analyze the absolute changes in bottom water temperature in the Pacific during the past four years to test the assumption that the bottom water temperature in the deep ocean is constant with time. This is the basic assumption governing the measurement of the outward flow of heat through the ocean floor.

SUPPORTED BY U.S. National Science Foundation

7.0101, GEOLOGICAL OCEANOGRAPHY - ACOUSTICAL PROPERTIES OF SEDIMENTS

J.J. GALLAGHER, U.S. Navy, Underwater Sound Lab. , *New London, Connecticut*

Objective: To determine those environmental factors affecting acoustical uses of the ocean. To investigate and define the physical properties of the ocean bottom sediments and the statistical character of the bottom topography and relate to acoustical scattering and attenuation.

Approach: Using submersibles and surface vessels, make in situ measurements of sound velocity in sediments, obtain cores in both deep and shallow water and analyze for properties of interest. Develop and use in situ probes. Make photographic and echo-sounding records of bottom topography and roughness, both macro- and micro-relief. Make laboratory analyses and do routine core analysis under contract with the University of Rhode Island.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0102, HYDRAULICS AND DYNAMICS OF ESTUARIES

T. SAVILLE, U.S. Army, Coastal Engin. Res. Center, *Washington, District of Columbia* 20016

Hydraulics and dynamics of inlets and estuaries, including both flow and sedimentation and erosion processes will be studied in models and the field, with theoretical analysis. Estuarine erosion as a result of wave action and high water levels will be a specific part.

SUPPORTED BY U.S. Dept. of Defense - Army

7.0103, MARINE GEOLOGY STUDIES, GULF OF MEXICO-CARIBBEAN REGION

H.L. BERRYHILL, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

Long-range objectives are: (1) A systematic and coordinated study of the tectonic framework of the Gulf of Mexico-Caribbean region; as a means of determining how the geologic setting affects modern sediment patterns and how tectonic movements affected the accumulation of thick sequences of sedimentary rock in the past; and (2) an appraisal of the marine resources of the region and an understanding of the relation of occurrence and distribution of these resources to geologic processes.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0104, WESTERN PACIFIC ISLANDS

G. CORWIN, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

In the Hawaiian Island group the objective is to determine the submarine extent, sequences, and kinds of recent lava floors off Hawaii, thus supplementing the onshore studies of volcanism of the Hawaii Volcano Observatory. Investigations will continue off Island Territories including the Trust Territory of the Pacific. These are concerned with specific problems of structure and changing sea level that have come into focus as a result of the geologic mapping of these islands by the U. S. Geological Survey.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0105, ARCTIC BASIN HEAT FLOW

A. LACHENBRUCH, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

This task investigates the distribution of earth-heat flow throughout the Arctic Ocean Basin and, insofar as possible, identifies the controlling factors. Field studies are conducted aboard drifting ice stations. Direct measurements are made of thermal gradients in bottom sediments by means of lowered thermal probes. Bottom cores are retrieved for subsequent laboratory analysis of thermal conductivity. Values of heat flow at each locality are calculated by multiplying temperature gradient by thermal conductivity and correlated with similar data derived in continental arctic regions to establish a world-wide pattern of heat flow.

Establishment of a heat flow pattern in the Arctic Basin is essential to understanding the region's crusted history and distribution of zones of volcanism and volcanic activity. Heat flow data in combination with other available geophysical evidence, further determine the nature of materials and processes in the earth's crust.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0106, GEOPHYSICAL SURVEYING AND CHARTING

A.J. HECKELMAN, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objective: Develop high speed survey techniques which will increase, by a factor of three or more, the rate of data acquisition for charting deflection of the vertical. Charting deflection of the vertical presently involves classical mathematical solutions to gravity survey data.

Present survey capabilities are not adequate to chart deflection of the vertical in the desired time frame. High speed platforms (40 knots or better) could operate in conjunction with these survey ships thereby increasing the volume of data available for the standard reduction technique and possibly a technique could be devised to determine directly the deflection of the vertical by passing the standard classic mathematical solution thereby reducing the amount of survey required for each area. Determine minimum repeat airborne survey effort required to correct world magnetic charts for secular variation in order to attain chart accuracy.

Approach: Participate in the DOD triservice helicopter gravity measuring system (HGMS) test. Evaluate test results and develop specifications and techniques for navy utilization of HGMS. Test gravity meters on board other types of high speed platforms and develop techniques for this utilization. Determine the feasibility of directly measuring deflection of vertical from a ship or aircraft. Prepare specifications for a deflection of vertical sensor. Procure, test and evaluate a deflection of vertical sensor. Determine a best mathematical model for the world magnetic field. Isolate harmonics which vary with secular variation. Determine relationship of secular isoporic foci with geologic zones. Delineate areas requiring repeat surveys.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0107, SEAMOUNT INVESTIGATION

P.T. TAYLOR, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objective: To complete the analysis of geophysical data obtained during FY 1968. Present these data in oral and written form. Schedule and participate in two cruises on a ship of opportunity basis.

Approach: After final data reduction the geophysical results obtained in FY 68 will be analyzed. These results will be illustrated and prepared for presentation at a scientific meeting. The results of last FY show that the seamount in question warrants further study. A small survey of this seamount by the USNS SHOUP is planned in FY 69 (2nd Quarter). This will enable gravity data to be collected which will greatly aid in further interpretations. Another cruise aboard the USNS COMPASS ISLAND is planned with Hudson Laboratories. This will enable the investigators to use the technique of acoustic signalling to detect seamounts. A geothermal probe plus thermal conductivity device will be obtained, and will aid in testing why the seamount under study has an uncommon magnetic anomaly pattern. These devices are scheduled for use in the first quarter - FY 1970.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0108, ACOUSTIC PROPERTIES OF SEDIMENTS

R.S. WINOKUR, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objective: To conduct basic research to investigate the acoustic properties of bottom sediments in order to provide a basic understanding of the interrelationships between the acoustic and physical properties of the sea floor and subbottom.

Approach: Investigations will be conducted in the field and laboratory to determine the acoustic properties, such as compressional and shear wave sound speed, and absorption, of sediments collected from a variety of physiographic provinces and to determine fundamental relationships with sediment physical properties. Statistical methods will be used to identify significant relationships in order to develop quantitative predictions of the acoustic properties of sediments. Shear and compressional wave sediment sound speed measurements will be made as a function of hydrostatic and overburden pressure, as well as temperature. In situ sound speed and absorption measurements will be made by seismic methods and by utilizing ocean bottom hydrophones and sediment probes. The acoustic properties of consolidated as well as unconsolidated sediments will be investigated by utilizing the long cores collected during the JOIDES program. Estimates of sediment elastic properties will be made from the acoustic and physical properties, and the acoustic properties will be compared to theoretical predictions. Whenever possible, correlations between time-stratigraphic surfaces and acoustic layering will be sought.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0109, OCEAN-SEDIMENTS AND CRUSTAL STRUCTURES IN THE BHAMIAN-CARIBBEAN AREA

M. BALL, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124 (NONR)

Objective: Navy needs for deep-sea salvage and other operations and for installation of engineering structures in the Bahamian-Caribbean region require knowledge of ocean sediment and rock structures in that area. These activities are affected by variations in crustal structures, particularly those associated with the unusually steep continental slopes in the area. This research will provide knowledge on the structures and compostion of sediment layers and crustal rocks in the Caribbean Sea, across continental slopes off eastern Florida and the Lesser Antilles Islands, and in the Bahamian region.

Approach: Seismic reflection and refraction measurements will be made from a ship to determine sediment thicknesses and structures, and crustal layering at selected sites in the Bahamian-Caribbean area. Emphasis will be on structures across the continental-oceanic transition zone. Sediment cores and bottom photographs will be obtained to determine sediment composition and evidence of bottom currents. Magnetic measurements will be made with a ship-towed magnetometer to determine structures beneath sedimentary rocks.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0110, GEOLOGICAL AND GEOPHYSICAL INVESTIGATION OF THE BAHAMA BANK

M.M. BALL, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

A geophysical and geologic investigation of the continental to oceanic crustal transition zone at the eastern edge of the Great Bahama Bank will be carried out as a continuation of past research. Objectives during the two years period are to complete bathymetric mapping of the study area, construct networks of magnetic and reflection seismic profiles over the study area, and extend and cross tie existing gravity data to serve as a basis for constructing approximate crustal models. In connection with these aims it is hoped to define and interpret the shallow structures that reconnaissance measurements have revealed in Exuma Sound and in the Atlantic Ocean to the east, and identify the rock and sediment types and ages involved in these structures. Ultimately it is hoped to discern the nature and configuration of boundaries within the crustal transition zone above and including the Mohorovicic.

SUPPORTED BY U.S. National Science Foundation

7.0111, A STUDY OF THE STRUCTURAL RELATIONS BETWEEN THE MID-PACIFIC OCEANIC RIDGES AND FRACTURE ZONES

A. MALAHOFF, Univ. of Hawaii, Graduate School, *Honolulu, Hawaii* 96822

The structure and physiography of the fracture zones and ridges of the mid-Pacific have obvious bearing on the origin of the Pacific Ocean Basin and the stress patterns that gave rise to these mid-oceanic features. The mid-oceanic features have obvious tectonic and stress relations to the margins of the Pacific, where land located slip-strike faults and north-south aligned magnetic anomalies near the California coast contrast sharply with the largely eastwest striking anomalies of the Molokai and Murray Fracture Zones near the Hawaiian Islands. Therefore a pilot geologic and geophysical study over the whole length of such a fracture zone as the Murray would do much to resolve where the north-south striking magnetic anomalies give way to the east-west striking ones and how the fracture zone is related to such prominant features as the Hawaiian Ridge, the Marcus-Necker Ridge, the Line Islands Ridge and other fracture zones, such as the Molokai. The Molokai Fracture Zone and its relationship to the Hawaiian Ridge has already been studied intensively in the neighborhood of the Hawaiian Islands. A pilot study as outlined above is proposed in the following program: (1) Total force magnetic surveys in a broad swath across the postulated strike of the Murray Fracture Zone (2) Seismic reflection studies to detect any vertical displacements in the sedimentary layers along the postulated strike of the Murray Fracture Zone (3) Precision echo-sounding surveys to accurately map the bathymetric features in the proposed area of survey (4) Selected gravimetric profiles across the Marcus-Necker Ridge (5) Dredging of hard rock samples along the Marcus-Necker Ridge and sedimentary coring in the basins adjacent to the ridge and (6) Bottom photography along the crest of the Marcus Necker Ridge.

SUPPORTED BY U.S. National Science Foundation

7.0112, GEOPHYSICAL AND GEOLOGICAL STUDY OF THE DARWIN RISE

G.P. WOOLLARD, Univ. of Hawaii, Graduate School, *Honolulu, Hawaii* 96822

Two two-month research cruises will be made to the area of the Darwin Rise in the western central Pacific. Observations will include bathymetry, seismic reflection, shallow refraction, gravity, magnetics, heat flow, bottom photography and seidment coring. The intent is to generate an adequate geophysical description of the area so that conflicting theories concerning the nature of the feature and its relationship to the evolution of the ocean basin can be examined. This one year program is in the nature of a reconnassance to set the stage for more definitive studies which will include deep refraction measurements.

SUPPORTED BY U.S. National Science Foundation

7.0113, MARINE GEOPHYSICAL STUDIES IN THE PACIFIC OCEAN

G.P. WOOLLARD, Univ. of Hawaii, Hawaii Inst. of Geophysics, *Honolulu, Hawaii* 96822

The Navy must understand the physical properties of the oceanic environment and the processes affecting them in order to execute its missions effectively. Objectives of this task meet these Navy needs and in the study of the deflection of the vertical (local distortion of the earth's shape as determined by gravity and satellite data), the study of bottom roughness & biological distributions in the ocean depths, the development of an improved capacity for accurately charting ocean positions, and the development of technique for predicting gravity in unsurveyed areas.

The contractor will acquire data at sea generally in the vicinity of the Solomon Islands. Data will include bathymetric, heat-flow, gravity, seismic profiles, seismic refraction, magnetic, sediment-core and ocean current data. These data will be analyzed at the university and used to determine the structure of the earth's crust, to infer the processes which are responsible, and to obtain the critical qualities outlined above.

SUPPORTED BY U.S. Dept. of Defense - Navy

7. MARINE GEOLOGY

7.0114, SEARCH FOR FERROMAGNETICALLY TRAPPED MAGNETIC MONOPOLES OF COSMIC RAY ORIGIN

B. LAX, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139

The existence of elementary particles carrying magnetic charge was predicted by Dirac in 1931, and appears even more plausible in the light of current theory, despite the failure of several attempts to find them. Dirac 'monopoles' may be too massive to have been produced in three synchrotron experiments (Berkeley, CERN and Brookhaven), and too rare to have been observed directly among the cosmic radiation. However, incident monopoles may have been accumulating in ferromagnetic minerals, where they would remain permanently trapped with substantial binding energy. Incident monopoles, whether of primary origin or produced by energetic events in the atmosphere, should arrive with energies of 10 to the 16th power to 10 to the 20th power electron volts, enough to cause considerable penetration and dispersion in surface rock. A sufficient depth of ocean water, however, would decelerate monopoles without immobilizing them and allow them to follow lines of the Earth's magnetic field to the bottom, where they would be trapped and accumulate near the surface. Sediments from great ocean depth therefore represent the most promising terrestrial source of magnetic monopoles. Magnets generating very intense, continuous magnetic fields have been used to extract monopoles from a variety of materials, and detect them by scintillation counters and nuclear emulsions. Results are as yet inconclusive, and the method is being refined for application to quantities of sediment sufficient to represent a significant area-time product of total cosmic radiation flux. Magnetic monopoles might account for the high-energy component of cosmic radiation, for the observation of 'extensive air showers', for the energy emission of 'qasers', and for reversals of the Earth's magnetic field as deduced from paleomagnetic studies. They would also provide a theoretical basis for the quantization of electric charge.

SUPPORTED BY U.S. Atomic Energy Commission

7.0115, MARINE GEOPHYSICS

F. PRESS, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139 (NONR)

This task concerns (1) developing heat flow instruments and making heat flow measurements across the mid-Atlantic Ridge and the Caribbean, Mediterranean and Red Seas aboard various research vessels; (2) analyzing the heat flow data in these areas and correlating them with other recent geophysical data obtained by various organizations; and (3) compiling, reducing, and interpreting available geophysical data for the entire Caribbean area.

Accurate knowledge of the relation of sub-bottom ocean structures with such geophysical anomalies as gravity, heat-flow, magnetics, and estimated mantle temperatures, and the correlations of these features with sea floor topography are important to a variety of naval operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0116, ATLANTIC OCEAN CRUSTAL STUDIES

C.O. BOWIN, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

A geophysical and geological investigation will be made of the area between latitudes 12 degrees and 22 degrees North and longitudes 45 degrees and 65 degrees West. The area contains the Lesser Antillean Island Arc, a portion of the Mid Atlantic Ridge, and the region between. The investigations will utilize the R/V. CHAIN and an aircraft. The techniques of seismic reflection, bathymetric, magnetic and gravity profiling, dredging, coring, bottom photography, and measurement of heat flow will be employed.

SUPPORTED BY U.S. National Science Foundation

7.0117, STRUCTURE OF CONTINENTAL RISE OFF EASTERN NORTH AMERICA

K.O. EMERY, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

Work completed to-date by scientists of Woods Hole Oceanographic Institution and of other oceanographic organizations indicates that the continental rise off eastern North America is a large depositional feature formed mostly during the Cenozoic Epoch. It is planned to make continuous seismic profiles supported by magnetic and gravity measurements along about 7500 km of ship track arranged in ten profiles between Grand Banks and Florida during July and September 1967. Necessary techniques and equipment (except for replacement parts) are already in operation and can easily be applied to the proposed program. The results should provide useful information about the thickness, extent, volume and layering of the continental rise. Deductions about the rate of deposition of the sediments, the role of turbidity currents during the Cenozoic, and the best positions for Ocean Sediment Coring drill holes can be made from this geophysical field study.

SUPPORTED BY U.S. National Science Foundation

7.0118, WOODS HOLE ENVIRONMENTAL STUDIES OF SEA FLOOR PROPERTIES

E.E. HAYS, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (NONR)

OBJECTIVE: To acquire data on sea floor properties of structure and reflectivity, geomagnetics, and gravity. Gravity measurements are used to define the geoid, and thus are important in the making of accurate charts of the earth, and by helping to determine the inclination of a 'level' surface at any point bear on navigation techniques and systems.

APPROACH: Carry out a program of 'at sea' acoustic reflectivity measurements on the topography and materials of the sea floor and sub- bottom. Collect concurrent bathymetric, magnetic and gravimetric data to aid in characterizing the general acoustic properties of the sea floor. A major cruise to the Mid-Atlantic ridge area north of the Azores for the above purpose is planned. Cores, for direct acoustic analysis, and dredge samples, for geologic and magnetic typing will be collected. A new gryo-stabilized gravity meter will be evaluated at sea. The acquired data, of all types, will be analyzed to promote development of an overall consistent picture of the 'acoustic' sea floor.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0119, ANALYSIS OF SEISMIC DATA COLLECTED DURING THE INTERNATIONAL INDIAN OCEAN EXPEDITION AND IN THE CARIBBEAN SEA

J.B. HERSEY, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

The purpose of this study is to analyze seismic reflection profiles and bathymetric data, to construct structural models where data warrant and to relate seismic results to the accompanying gravimetric and magnetic data as well as the analysis of rock samples.

A single major cruise to the Indian Ocean has enabled the recording of continuous seismic reflection profiles across the North Atlantic Ocean, in the Mediterranean Sea, and the Indian Ocean. In the Indian Ocean, the principal sedimentary structures of the Somali Basin and those of the Seychelles-Mauritius ridge have been explored by means of several long, crossing profiles. Red Sea criss-cross profiles define a central area of rift and bordering area of stratified rock (probably sediments). In the Mediterranean a detailed structural study of the Lebanese shelf was made followed by a criss-cross profile over the Nile Delta and central sedimentary basins of the eastern Mediterranean. Later a detailed survey of the Ligurian Sea was conducted followed by a single profile through the Balearic Basin and the Strait of Gibraltar, and thence northward to Plymouth, England. Over the outer ridge north of Puerto Rico a complex and detailed seismic refraction profile was recorded.

SUPPORTED BY U.S. National Science Foundation

7.0120, GEOMAGNETIC INVESTIGATIONS

J.D. PHILLIPS, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

This task concerns measurement of the earth's magnetic field, using proton precision magnetometers towed from Woods Hole ships. Magnetic profiles will be interpreted in terms of sea floor spreading and other geologic structures; the magnetic data will be related to other parameters, as bottom topography, heat flow, gravity anomalies, and rock type. Detailed measurements are planned for parts of the mid-Atlantic Ridge.

The magnetic studies contribute to an understanding of rock types beneath the ocean floor, which affect deflections of the vertical, underwater sound propagation, salvage and rescue operations, and engineering structures.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0121, GEOTHERMAL INVESTIGATIONS IN OCEAN REGIONS

G. SIMMONS, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

A two-year program to investigate geothermal problems in oceanic regions is proposed. Emphasis is placed on measurements of heat flow through the Atlantic Ocean floor, mainly utilizing WHOI research vessels. Instrumentation is requested to take advantage of research cruises proceeding to or crossing regions of interest, and new techniques will be developed to attack some of the outstanding problems in this field. Special studies and detailed surveys are planned to investigate sources of variability in heat-flow values in some regions, and models will be studied for comparison with results from these surveys.

In a broad sense, the principal goal of the proposed investigations is to improve our understanding of the dynamic processes within the earth as reflected in the geothermal flux. More specifically, it is planned to investigate (a) the significant regional heat-flow variations in the Atlantic, and their possible relationships with geological structure, and (b) the source of local variability in heat-flow values from the ocean floor, with the aim of improving the reliability of measurements in some regions.

SUPPORTED BY U.S. National Science Foundation

7.0122, GEOTHERMAL STUDIES IN DEEP-SEA DRILL HOLES

R.P. VONHERZEN, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

It is proposed to measure the heat flux from the earth's interior on programs which drill and sample sediments from the deep ocean floors. Such measurements on the Deep Sea Drilling Program, for example, should establish 40 - 60 very reliable heat-flow values at sea, to which the 2000 oceanic measurements already obtained by conventional techniques may be compared. Furthermore, it may be possible to obtain reliable measurements from other research and commercial drillings on the continental shelves and slopes, areas which are not normally accessible to standard oceanic techniques. The proposed measurements will result in oceanic values by techniques which are more nearly similar to those made in continental bore holes, thereby allowing a more reliable comparison between these fundamentally different regions.

Initial efforts will involve development of suitable instruments and techniques.

SUPPORTED BY U.S. National Science Foundation

7.0123, GEOTHERMAL INVESTIGATIONS IN OCEAN REGIONS

R.P. VONHERZEN, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

This task is a continuing investigation on the heat flux conducted through the earth's surface in selected regions of the Atlantic Ocean. Measurements of heat flow are made from ships with probes at various points on the ocean floor, particularly on the mid-Atlantic Ridge and the Vema Fracture Zone. Water temperature distribution near the bottom at station locations is also determined. Heat flow is analyzed in terms of the geologic province, bottom topography, sources of the heat, and depth of source. Instrumental developments are made to improve the measuring system.

This program attempts to improve the measurements of heat flow in oceanic areas and determine the relation of heat flow to bathymetry, sediment structures and thicknesses, and to crustal and subcrustal rocks. Heat flow studies thus improve our knowledge of the materials below the sea floor; these materials affect such Navy relevant problems as underwater sound propagation, gravity and magnetic fields of the earth, ocean engineering construction, and salvage and rescue operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0124, GREAT LAKES RESEARCH - COASTAL AREA SEDIMENTATION

J.H. SAYLOR, U.S. Army, Lake Survey, *Detroit, Michigan* 48226

Data on energy sources (waves, winds, currents) impinging on selected coastal reaches along the Great Lakes will be collected and studied to learn how environmental energy affects sediment movement, characteristics, and distribution in beach and nearshore areas. Results will be used to derive relationships and/or mathematical models. Investigations will devise methods of establishing rates of coastline change and how to forecast the future behavior of the coastline. Information is needed for the design and location of harbors, marinas, industrial plants, and recreational areas.

Data collection at Little Lake Harbor on Lake Superior was completed in 1964, and a report was presented at the Tenth Conference on Coastal Engineering held in Tokyo, Japan.

Data collection on Lower Lake Huron in the vicinity of Port Huron, Michigan and Sarnia, Ontario, was completed during 1965. Analysis of the data is in progress.

Preliminary investigations were conducted at Pentwater, Mich on the eastern shore of Lake Michigan during 1967. An intensive field program is planned at Pentwater during the spring and fall of 1969.

SUPPORTED BY U.S. Dept. of Defense - Army

7.0125, GENERAL COASTAL INLET STUDIES

J.B. TIFFANY, U.S. Army, Waterways Experiment Sta. , *Vicksburg, Mississippi*

The objective of this research project is to develop means for computing discharge and velocity distribution through tidal inlets leading to determination of tidal prisms and water surface elevations in inner bay systems; and to determine the factors involved in both inner and outer bar formation, the shoaling of inlet channels, and the stability of inlet shape and location. The following four facilities are being used to conduct necessary investigations: 1. Facility A. This is a facility in which inlets of various shapes can be modeled to a relatively large scale, and tests conducted therein under varying tidal conditions to establish discharge coefficients, flow patterns, and other factors required to compute discharges over the range of head differentials. 2. Facility B. This facility consists of an 'ocean' in which tides of various amplitudes and periods could be generated, a lagoon which could be varied in areas and shapes, and a connecting section between the two in which inlets of various shape could be modeled to a small scale by standard fixed-bed model techniques. 3. Facility C. This facility consists of a movable-bed model ocean, equipped with appurtenances for reproducing tides, waves, littoral currents, and other significant forces; a fixed-bed lagoon which could be varied in area and shape; and provisions for connecting the two by means of a movable-bed inlet section in which inlets of various shape could be modeled by movable-bed model techniques. 4. Facility D. An existing 350-ft by 175-ft basin now in existence at the Coastal Engineering Research Center will be used to develop information on the distribution and quantity of along-shore littoral drift, as a function of wave height, wave length, and other significant factors.

SUPPORTED BY U.S. Dept. of Defense - Army

7.0126, EXPLOSIVE WAVE PROPAGATION

C.L. PEKERIS, Amer. Comm. For Weizmann Inst. , *New York, New York* (N00014-67-C0146)

Theoretical studies will be conducted on (1) the propagation of explosive pulses in layered media by using new methods of inversion of the Laplace integral equation; (2) the equation-of-state of matter in the interior of the earth. In addition, methods of digital analysis of seismic data will be extended in an attempt to better resolve closely spaced yet discrete frequency components. Work will continue on improving the seismic travel-time curves for P waves.

The analytical techniques developed for use in studies of explosive wave propagation and the results obtained from these studies will contribute to naval capabilities in the use and analysis of underwater sound signals, including the propagation in the layered sediments and rocks beneath the ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0127, PARTIAL SUPPORT OF A PROGRAM OF EDUCATION & RESEARCH IN MARINE SEISMOLOGY AND GEOMAGNETICS

M. EWING, Columbia University, Graduate School, *New York, New York* 10027

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY New York State Science & Technology Found.

7.0128, MARINE GRAVITY

M. TALWANI, Columbia University, Graduate School, *New York, New York* 10027

Continuous surface ship gravity data will be acquired in part aboard R/V VEMA and in part aboard R/V ROBERT D. CONRAD. This work will include instrument development primarily aimed at decreasing the errors in gravity measurement. An accuracy of about 2 mgal is obtainable with present instrument and navigation techniques. By developing analog computers to correct for the off-levelling error associated with stabilized platforms, it is hoped to diminish the error below 1 mgal.

Navigation fixes are obtained by means of satellite navigation receivers that work with U.S. Navy's satellite navigation system. PDP-8/S computers aboard VEMA and CONRAD reduce these fixes. The computers do complete track adjustment on board ship.

SUPPORTED BY U.S. National Science Foundation

7.0129, GEOPHYSICAL INVESTIGATIONS IN THE TAIWAN-PHILIPPINE-NEW GUINEA REGION

M. EWING, Columbia University, Graduate School, *Palisades, New York* 10964

The purpose of the project is two-fold: (1) to continue the cooperative program with our Japanese colleagues to investigate geophysically unexplored regions of the oceans, (2) to help strengthen and promote new interest in the science cooperative program between the United States and Japan.

The main purpose of the work is to make seismic-refraction measurements of the following morphological units: (1) Taiwan-Luzon ridge, (2) Manila trench, (3) Celebes-Sulu Sea basins, including the Sulu archipelago, (4) West Caroline - East Caroline basins including the Caroline - New Guinea rise, and (5) Bismark Arch-New Britain trench system. Since the Snellius Expedition of 1929-1930, very little marine geological information has been collected in the proposed region of study; aside from the pendulum gravity measurements of Vening Meinesz no significant amount of marine geophysical data has been obtained. Therefore, the survey route is designed to provide data by seismic measurement, gravity, magnetics, coring, heat flow, etc., on a host of geophysical-geological proglems.

SUPPORTED BY U.S. National Science Foundation

7.0130, GEOPHYSICAL INVESTIGATIONS IN THE CORAL SEA

M. EWING, Columbia University, Graduate School, *Palisades, New York* 10964

The proposed survey calls for a two-ship operation utilizing radio-sonobuoys for multiple receiving points in making seismic refraction measurements at sea. This technique has the advantage of permitting the receiving ship to occupy a station amidst an array of buoys spaced in any pattern deemed suitable for the problem being studied. Multiple receiving points permit far more detail than is usually possible to obtain with the conventional two-ship technique; the ability of the mother ship to receive near its buoy spread (while the accompanying ship shoots the forward half of the profile, whence the procedure is reversed) removes the disadvantages associated with single-ship buoy seismology.

The Lamont vessel will also obtain continuous measurements of gravity, magnetics, bathymetry and sub-bottom sedimentary layering (seismic profiling). The purpose of the joint survey is to measure the crustal section from the Australian continental margin off Townsville across the Coral Sea Plateau, Coral Sea Basin to the Louisiade Arch of Southwestern New Guinea. The exact locations of seismic profiles and ship's tracks will be decided as the work progresses. The geophysical measurements will provide knowledge of the regional structure and may yield important clues as to its development and evolution.

SUPPORTED BY U.S. National Science Foundation

7.0131, MARINE SEISMOLOGY

W. EWING, Columbia University, Graduate School, *Palisades, New York* 10964 (N00014-67-A0108-0004)

Objectives of this research include: (a) the continuing investigation, on a world-wide basis of the distribution of unconsolidated sediments and the nature and origin of these sediments and their structural features; (b) determination of sound velocities in the sediments utilizing sonobuoys together with pneumatic and other sound sources in wide-angle reflection profiles; (c) studies of crustal and upper mantle structure using seismic refraction techniques; and (d) the continued development of improved hydrophone arrays and recording techniques for use in seismic reflection profiling.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0132, RESEARCH IN OCEAN PROPERTIES

W.M. EWING, Columbia University, Graduate School, *Palisades, New York* 10964

Objective: To determine those environmental factors affecting acoustical uses of the ocean; to observe and develop theory and model for predicting underwater sound propagation using deep ocean water paths including near bottom phenomena; to observe, define and obtain acoustical target strengths of volume scatters.

Approach: Data collection using ocean research vessels such as VEMA and CONRAD (AGOR-3). Make detailed surveys under precise navigational control in selected areas including continuous profiling of bottom and sub-bottom topography, reflectivity measurements, refraction measurements, bottom photography and deep sea cores as necessary. Monitor deep scattering layers qualitatively on the Precision Depth Recorder and obtain quantitative measurements of reverberation levels at selected times and places. Correlate these measurements with results of biological sampling programs supported by other agencies. This approach includes the development of instruments for determing ocean floor ambient noise, seismic characteristics of the immediate sub-bottom structure, bottom structure, bottom reflectivity and the small scale topography of the ocean floor.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0133, GEOPHYSICAL STUDIES FROM ELTANIN IN 1968

D.E. HAYES, Columbia University, Graduate School, *Palisades, New York* 10964

Lamont Geological Observatory of Columbia University has carried out geophysical oceanography research on the Antarctic Research Vessel U.S.N.S. Eltanin under GA-894 and earlier grants. Proposed research would include: (1) Seismic-reflection program to yield data on the boundaries between different sediment layers beneath the ocean floor and to indicate the thickness and attitude of the layers. (2) Gravity program, using a sea gravimeter installed last year for the interpretation of the composition and structure of the Earth's crust beneath the areas surveyed. (3) Magnetic program to yield data to extend interpretation of sea-floor spreading and paleomagnetic epochs into the areas south of New Zeland and Australia. LGO proposes to continue data reduction and publication. It is proposed to include two Australian scientists in the research party on the Eltanin as a part of a cooperative program between LGO and the University of New South Wales. The cruises planned would reach into an area in which little geophysical oceanography data is now available and which is of great geophysical interest because it includes as junction of the Pacific-Antarctic and Indian Ocean Ridge Systems. These programs by LSO, coordinated with research done on the Eltanin by other institutions, constitute at interdisciplinary approach to the problems of measuring and understanding the ocean environment in one of its least explored regions.

Five shipboard technicians (2 from Australia) will be on the Eltanin.

SUPPORTED BY U.S. National Science Foundation

7.0134, GEOMAGNETIC STUDIES

J.R. HEIRTZLER, Columbia University, Graduate School, *Palisades, New York* 10964

This program is involved with studies of geomagnetic micropulsation phenomena in the frequency range from 0.1 to 0.0001 cps. During this extension, work will continue on determining the propagation characteristics of these relatively short period geomagnetic fluctuations including their group and phase velocities and their degree of continuity from one location to another. In addition, a small study will be carried out on the perturbation in the local geomagnetic field which is expected to occur during passage of a Saturn rocket through the earth's ionosphere.

Naval capabilities in magnetic navigation and other areas are affected by the time variations of the earth's magnetic field. A fuller understanding of these geomagnetic fluctuations should permit the development of adequate techniques for removing or minimizing their effects.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0135, MAGNETICS

J.R. HEIRTZLER, Columbia University, Graduate School, *Palisades, New York* 10964 (N00014-67-A0108-0004)

The objective of this program is to measure and interpret variations in the earth's magnetic field. Emphasis will be placed upon continuing efforts in the growing field of paleomagnetic stratigraphy and in magnetic studies which bear on the concept of ocean-floor spreading. Studies of magnetic anomalies in the following geographical areas should be completed: circum-Pacific trenches, Norwegian Sea, and a second study of the Reykjanes Ridge.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0136, GEOTHERMAL MEASUREMENTS

M.G. LANGSETH, Columbia University, Graduate School, *Palisades, New York* 10964

This program is directed toward determining the heat flow through the ocean floor and relating the observed variations to bottom topography, to properties of the underlying sediments, crust, and mantle, and to fluctuations in bottom water temperatures. In addition, measurements of the vertical temperature profile throughout the water column will continue to be made. A multiple instrument package which includes a new thermal probe will be used extensively to provide closely spaced sets of data on the water-sediment interface.

A knowledge of the ocean's temperature structure from top to bottom is important in many operations. Space and time variations in the flow of heat out of the ocean-bottom sediments affect the temperature structure. This research program will help provide, on a world-wide basis, an understanding of the heat flow variations as well as information on the thermal structure itself.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0137, HEAT FLOW AND MAGNETICS IN THE PHILIPPINE SEA

M.G. LANGSETH, Columbia University, Graduate School, *Palisades, New York* 10964

The Lamont investigators will work with Dr. Masashi Yasui, Oceanographic Section, Maizuru Marine Observatory, Japan Meteorological Agency and his associates. The will examine the magnetics and heat flow in the Philippine Sea, in and around the Bonin Trench and Mariana Arc and Trench and over the inner arc ridges. The purpose is to study the magnetic lineation pattern, if any, and the heat flow to try to ascertain if this part of the ocean floor seems to be spreading as it is in the eastern Pacific.

SUPPORTED BY U.S. National Science Foundation

7.0138, HEAT FLOW MEASUREMENTS

M.G. LANGSETH, Columbia University, Graduate School, *Palisades, New York* 10964

Heat flow through the ocean bottom will be measured during the field program of the Lamont ships in conjunction with the sediment coreing program. A new instrument will be developed and used to make closely spaced heat flow measurements along with water velocity and turbidity near bottom as well as bottom photography. The effect of small-scale topography on heat flow will be studied especially in the mid-ocean ridge province.

SUPPORTED BY U.S. National Science Foundation

7.0139, STUDY OF RELATIONSHIP BETWEEN EARTHQUAKES AND TECTONIC MOVEMENTS IN ALASKAN FAULT ZONE

J. OLIVER, Columbia University, Graduate School, *Palisades, New York* 10964

The technical objectives of this grant are to develop better understanding of the relationhsip between earthquakes and tectonic movement which is expected will lead to more accurate prediction of the occurrence of destructive earthquakes.

The proposal is to study recent and current tectonics and seismic activity associated with two or more major Alaskan faults. The study will emphasize the combined use of several geologic and geophysical techniques in a single program. Specifically, the program will include investigation of (1) the amount, sense and rate of displacement in past and present tectonic movements; (2) the recent and present seismicity; (3) the relationship between current tectonic movement and seismicity; (4) the possibility of the future occurrence of earthquakes and tectonic movement.

Some studies have provided evidence that a reversal in the direction of tectonic movement occurs at the time of an earthquake. The number of shallow microearthquakes recorded in the Denali fault valley indicates that the fault is currently active.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

7.0140, DEEP EARTHQUAKES AND ISLAND-ARC TECTONICS AND STRUCTURE

J. OLIVER, Columbia University, Graduate School, *Palisades, New York* 10964

A three-year extension, including a small additional field program, of a study of deep earthquakes in the Fiji-Tonga region of the southwest Pacific (NSF GP-2539) is proposed. Discoveries of major importance have resulted from the current research and certain seismic phases have been found with special features which imply a major revision of conventional ideas of island-arc structure. Results to date include indication of anomalously low attenuation of seismic waves in or near the zone of deep earthquakes in the upper mantle and discovery of a number of systematic relationships between the configuration of seismic zones, focal mechanisms, and physiographic features of island arcs in the southwest Pacific. The proposed program calls for the continued maintenance of the network of five seismograph stations installed in the Fiji-Tonga region during the current project, operation of portable seismographs for special measurements, and the data analysis to investigate the following topics: mechanism of deep earthquakes as revealed by information in the wave form of the seismic signals and analysis of the sequence of occurrences in time and space; variations of attenuation and velocity of seismic waves in the upper mantle near the zone of earthquakes; and further study of the relationships among focal mechanisms, the configuration of the seismic zones, and other island-arc features. The proposed research will continue to be a valuable contribution to the U. S. Upper Mantle Program.

SUPPORTED BY U.S. National Science Foundation

7.0141, SEISMOLOGICAL RESEARCH RELATED TO WORLD-WIDE SEISMIC DATA

P.W. POMEROY, Columbia University, Graduate School, *Palisades, New York* 10964

The purpose of the research will be to investigate the properties of seismic sources, the distribution of these sources in space and time, the structure and state of the earth and the phenomena of wave propagation; and to relate these phenomena and information to problems of earthquake prediction.

Using recordings of seismic waves available from the stations of the World-Wide Standardized Seismograph Network of ESSA, make analytical studies of body and surface waves, detailed investigations of regional seismicity, generate computer programs for the study of focal mechanisms, seismicity, spectral analysis, seismic wave propagation.

The comparison of precisely determined hypocenters with the distribution of large-scale geological and geophysical features such as deep-sea trenches, gravity anomalies, volcanoes, and fracture zones. Long-period seismograms were used successfully in determining the sense of strike-slip displacement on a number of major fault zones on the mid-oceanic ridge system.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

7.0142, GRAVITY

J.L. WORZEL, Columbia University, Graduate School, *Palisades, New York* 10964 (N00014-67-A0108-0004)

This research is directed toward the measurement of the earth's gravity field over the oceans and the investigation and interpretation of the anomalous variations observed. Regional gravity anomaly maps will be extended and updated by the addition of newly obtained data. Studies of the anomalies over deep-sea trenches, island arcs, and mid- ocean ridges will continue. Investigations of the Caribbean area and the Philippines are expected to be completed. Further improvement in the accuracy of the gravity data is planned and two new gravity sensors are to be tested.

The accuracy of inertial navigation systems is presently limited by insufficient knowledge about the earth's gravity field and deflections of the vertical. This program is (1) providing gravity data over the world's oceans, (2) developing and evaluating new techniques and instruments for obtaining more accurate gravity measurements at sea, and (3) helping to provide the basic understanding of gravity variations which is necessary for the prediction of deflections of the vertical.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0143, ESTUARINE SEDIMENTARY MODELS

G.S. VISHER, Univ. of Tulsa, Graduate School, *Tulsa, Oklahoma* 74104

The primary aims are to provide information for a general process- response model for the tidal-estuary-distributary environmental association, and to test the hypothesis that texture may be used directly in the identification of specific sedimentary processes. Work on fluid flow in natural stream channels has demonstrated the association of textures with specific flow regimes. In addition, recent textural studies of clastic sediments suggest the possibility that texture may be used directly in determining ancient sedimentary processes in a more specific manner than previously possible. An observation program to test these hypotheses will be carried out in the estuary of the Altamaha River.

The data will be used to develop a statistical model of the area for comparison to ancient rocks, and to evaluate the effects of differing sedimentary processes on grain size distributions.

SUPPORTED BY U.S. National Science Foundation

7.0144, PACIFIC GRAVITY

G. BODVARSSON, Oregon State University, Graduate School, *Corvallis, Oregon* 97331 (NONR)

This task is a continuation of a marine gravity program in the Northeast Pacific Ocean. It concerns making gravity measurements aboard ship with an ONR-owned LaCoste and Romberg gravity meter S-9, determining gravity anomalies from these measurements, and determining crustal and mantle structures that are in agreement with these anomalies and other available geophysical data (particularly seismic refraction). The program also contributes to an evaluation of the accuracy of the meter under different sea conditions. New methods for machine handling and interpreting the gravity data will be investigated.

This program benefits the Navy in that gravity measurements at sea are of importance for local determination of the shape of the geoid and deflections of the vertical. The knowledge obtained on crustal structures has application to sound transmission in the oceans. Analysis of the reliability of the meter measurements is important for data evaluation with this and other meters of the same make.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0145, (U) OCEANIC CRUSTAL AND MANTLE STRUCTURE - ITS ORIGIN AND EFFECT ON EXTERNAL FILEDS

G. BODVARSSON, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

OBJECTIVE: This research, which is directed toward determining the nature and origin of the oceanic sediments and crustal rocks in the NE Pacific, will provide (i) basic data on the earth's gravity and magnetic fields and on the acoustical properties of sediments, and (ii) and increased capability for the prediction of these fields and properties in unsurveyed areas. Effective use of present and future sonar and magnetic detection systems in antisubmarine warfare requires an increased understanding of the acoustical properties of marine sediments and of the earth's magnetic field. In addition, future improvements in the accuracy of inertial navigation systems, which are extensively used in Naval ships and missiles, require an increased knowledge of the earth's gravity field.

APPROACH: Shipboard measurements of the gravity, magnetic and heat flow fields will be made in selected areas of the NE Pacific. Information on the thickness, structure and character of the ocean bottom sediments will be obtained by seismic reflection profiling, and by bottom sampling techniques. Using these combined data as a comparison standard, structural models of the oceanic crust and upper mantle will be generated and modified to agree with the field data. Satisfactory structural models will then be considered in terms of the forces and processes which could have led to their formation.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0146, MARINE GEOPHYSICS

G. BODVARSSON, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

A seismic 'air gun' type of profiling unit will be purchased and used aboard The R/V YAQUINA to measure thicknesses and structures of sediments in areas off the coast of the northwestern part of North America. The particular areas include the continental shelves and slopes west of California, Oregon and Washington, and in deep water in the areas of the Mendocino Escarpment, the Gorda and Juan de Fuca ridges, the Cascadia and Tufts abyssal plains, the Gulf of Alaska, and the Cocos Ridge off South America. Many, but not all, of these seismic measurements will be made in conjunction with cruises scheduled for other purposes.

The seismic reflection measurements provide data on thickness, the layering and structures of sediments at many localities off the northwest coast of the U.S. These sediments greatly affect the long- range propagation of underwater sound, the installation of engineering structures and salvage and rescue operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0147, SUBSURFACE RESISTIVITY

H.W. SMITH, Univ. of Texas, School of Engineering, *Austin, Texas* 78712 (NONR)

Magnetotelluric techniques will be used to provide information on the deep structure of the continental-oceanic transition zone. Measurements will be made along a line from central Texas to the Gulf Coast and at additional sites along the coast. The apparent resistivity curves determined from the data will be compared with theoretical curves from layered models extending to depths on the order of 100 km. The study will utilize improved magnetotelluric analysis procedures which were recently developed by the contractor under a previous contract.

The potential use of the earth's crust as a transmitting medium for communications purposes is presently being explored. Evaluation of this potential use requires information concerning the electrical properties of the earth's crust and upper mantle. This research will help provide such information.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0148, GEOPHYSICS, GULF OF MEXICO

J. ANTOINE, Texas A & M University System, Graduate School, *College Station, Texas* 77843 (NONR)

The objective of this research is to investigate the geological and geophysical structure of the Gulf of Mexico, the Yucatan Basin, and the Cayman Trough. The extent of the fold system off the eastern coast of Mexico will be further delineated and an attempt will be made to correlate this structure with the onshore geology. Structural studies in the Gulf basin adjacent to the South Florida platform will be continued. Studies in the eastern end of the Cayman Trough will be initiated. Techniques to be employed will include seismic reflection profiling, wide-angle reflection and refraction, magnetics, precision depth sounding, and sediment sampling.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0149, MARINE GEOPHYSICS

A.L. HALES, Southwest Ctr. For Adv. Stud. , *Dallas, Texas*

This research program is directed toward marine geophysical investigations of crustal structure in selected areas. Seismic field work will be conducted along the southern margin of the Gulf of Mexico and off the southeast coast of South Africa which will supplement data previously obtained in these areas. Analyses of geophysical data obtained in the Coral Sea and the Pacific Ocean off Panama will be completed.

The effectiveness of many naval systems is dependent on a knowledge of the acoustic properties of ocean-bottom sediments and on a knowledge of the earth's gravity field respectively. This program should increase effectiveness in these operational areas by: (1) providing information on the acoustic properties of marine sediments in selected areas, and (2) helping to develop an understanding of oceanic crustal structues, their history, and how they affect the local gravity field.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0150, SUBMARINE SEISMIC PROFILES OF THE WORLDS OCEANS

N.A. MOORE, Teledyne Incorporated, *Houston, Texas* 77036

Record and interpret sub-bottom seismic profiles of the world's oceans using proprietary high-energy acoustic sources and low noise hydrophone streamer cables.

Profiles across the Atlantic from Trinidad to West Africa, around Africa, across the Indian Ocean and through Indonesia have been completed for approximately 35,000 miles. A crossing of the Pacific Ocean will begin in late 1968.

SUPPORTED BY Teledyne Exploration Company

7.0151, SEISMIC, MAGNETIC, AND ACOUSTIC STUDIES ON THE CONTINENTAL MARGIN OFF WASHINGTON

L.C. BENNETT, Univ. of Washington, Graduate School, *Seattle, Washington* 98122 (NONR)

Objective: Naval operations along continental margins can be made considerably more efficient if the local variations in bottom sediment properties and in magnetic field strength are either known or predictable. This research will provide (1) basic bathymetric, geomagnetic, and sedimentary information on the continental margin off of Washington, and (2) a better understanding of the relations between the acoustic absorption in sediments and the mechanical properties and structures of the sediment.

Approach: A field observation program utilizing continuous seismic reflection and magnetic profiling, short-pulse echo sounding, bottom photography, and bottom sampling will be carried out. From these data, sediment properties, ages, and structures will be determined. Specific parts of the seismic reflection data will be analyzed for the reflectivities of particular subbottom reflecting horizons and for the acoustic absorption between selected horizons.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0152, DETAILED STUDY OF THE OCEANIC CRUST BY MEANS OF DEEP SEISMIC PROFILING

C.R. LISTER, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The purpose of this study is to initiate geophysical surveys on the continental shelf off Washington State. The scientific plan for geophysics at the University is to begin a detailed survey of a deep- ocean area reasonably close to home. This survey will be controlled by anchored navigation buoys and punctuated by a number of heat-flow core stations.

Detailed heat-flow surveys have always been difficult to interpret because of the bias that arises from the refraction of the heat flux by topographic features, both surface and sub-bottom. The Conductivity contrast between hard rock and pelagic sediment is five to one or more, with the result that measurements of heat flow in soft-bottomed vallyes are systematically low, as would be any measurements in the thin sediment cover that sometimes tops a seamount or guyout (due in this latter case to the surface topographic refraction, with much of the heat lost on the sides of the seamount). The most useful supplementary geophysical tool is a sub-bottom profiler, powerful enough to penetrate 1 km of sediment but not necessarily needing to penetrate any of the hard rock. Such a device is requested as a part of the proposed research.

SUPPORTED BY U.S. National Science Foundation

7.0153, THE MAGNETIZATION OF SUBMARINE BASALTS AND ITS EFFECT ON MARINE MAGNETIC ANOMALIES

R.T. MERRILL, Univ. of Washington, Graduate School, *Seattle, Washington* 98122 (NONR)

OBJECTIVE: An understanding of the origins of marine magnetic anomalies, which form a part of the noise environment, will allow more adequate predictions to be made of the magnetic field characteristics likely to be encountered in unsurveyed areas. This research is directed toward determining the relative importance of self-induced magnetic reversals in marine basalts and the effects of such self-reversals on the interpretation of marine magnetic anomalies.

APPROACH: Several rock samples, whose orientation with respect to the north-south and vertical directions is known, will be collected from Cobb Seamount off the Washington Coast. Laboratory tests on these samples will be carried out to determine the location of the north magnetic pole at the time the sampled rock was formed. Further testing will be done to determine whether magnetic self-reversals have occurred and to study the origin of remnant magnetization. Utilizing the results of these tests, analyses of magnetic, gravitimetric and bathymetric data over Cobb Seamount will be made to determine the validity of assumptions on rock magnetization which are frequently used in such analyses.

SUPPORTED BY U.S. Dept. of Defense - Navy

7. MARINE GEOLOGY

7.0154, GRAVITY SURVEY ARCTIC OCEAN

R.J. WOLD, Univ. of Wisconsin, Graduate School, *Milwaukee, Wisconsin*

The Beaufort Sea overlays a broad continental shelf which comprises a significant portion of the Arctic Ocean Basin. Accordingly, this shelf is basic to any attempt to define and interpret geophysical structure of the Arctic Ocean. This task will enable the contractor to conduct studies in gravity, seismic refraction utilizing airlift capabilities and the ice cover as a convenient stable platform. Data thus obtained will contribute to knowledge of flattening of the geoid in Polar areas, bathymetry and geologic nature of the continental shelf.

These studies have important bearing on greater and more precise geodetic and navigational control in this region.

SUPPORTED BY U.S. Dept. of Defense - Navy

7E. HISTORICAL GEOLOGY

(*interpretation of History of Oceans, Ocean Floor, and Coastal Areas.See Also Chapters 7f Paleontology and 7c Geochemistry.*)

7.0155, GEOLOGIC HISTORY OF BERMUDA AND ITS RELATIONSHIP TO THE WORLD PLEISTOCENE

F.T. MACKENZIE, Bermuda Biolog. Sta. For Res. , *Saint George, Bermuda*

An integrated stratigraphic, paleontological and bathymetric study of Bermuda is planned as a basis for interpreting sea level changes during the Pleistocene. Sea level changes have been important events in earth history and have exerted a strong influence on present-day sedimentation and coastal processes, as well as biogeography. An understanding of sea level fluctuations is best gained from investigations of tectonically stable areas, such as Bermuda was during Tertiary and Quaternary time.

Because the position of transition zones between marine limestones and eolianites give information concerning past sea levels, detailed stratigraphic study will be an integral part of the proposed work. Paleontological data will help define time-stratigraphic units, especially in terrestrial deposits. Bathymetric investigations will aid in recognizing submerged Pleistocane terraces.

The proposed coordinated study will hopefully lead to: 1) an interpretation of the geologic history of Bermuda, 2) the definition of a Pleistocene sequence uncomplicated by tectonic activity, and 3) the establishment of a 'tide gauge' with which other Pleistocene sequences on the continents and other areas may be compared.

SUPPORTED BY U.S. National Science Foundation

7.0156, GEOLOGIC HISTORY OF PACIFIC FAUNAS

E.C. ALLISON, San Diego State College, Graduate School, *San Diego, California* 92115

It is proposed to study fossiliferous rock samples obtained from dredge hauls taken from the Pacific sea floor. Immediate objectives of the research are to provide insights into certain fundamentally important paleobiological problems such as: 1) history of the East Pacific barrier, based in part on distribution patterns of tropical shallow marine organisms, 2) origin and evolution of the Galapagos Islands fauna, and 3) development and changes of isolated reef faunas. Long range objectives aim at providing information relative to such problems as: a) age and geologic history of sea floor structures, b) extent and chronology of sea level changes during recent geological history of ocean basins, c) history of marine faunas, especially insular marine forms, and d) distribution of past climatic belts.

SUPPORTED BY U.S. National Science Foundation

7.0157, QUATERNARY ENVIRONMENTS AND BIOTAS

C.L. HUBBS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The project includes many disciplines and approaches such as: paleoclimatology, paleoecology, paleozoogeography, paleooceanography, paleohydrography, geology, and archeology, and involves the use of such tools as isotope analyses, past and present temperature and faunal surveys, computor analyses, and collection and processing of material from kitchen middens.

The results of the study will have bearing on the distribution of littoral plants and animals, and constitutes one of the most basic parameters in the interpretation of past as well as present change in temperature and in the biota.

Further efforts are to be made to obtain measurements of paleotemperatures using a mass spectrometer. Geomorphic as well as faunal and climatologic data are to be collected for the Sangamon Interglacial fossil deposit on Isle Guadalupe to obtain information on the last Interglacial on the Pacific Coast. The investigation is to be extended to the isolated basin of Cuatro Cienegas in northeastern Mexico, which exhibits an extraordinary incidence of endemism, and to collaborate with others on the study of the basin and its fauna. In coopration with archeologists and geologists, furhter studies will be made of the Pluvial and Postpluvial history of the Ancient Lakes in western North America. Field work is to be completed on the correlated hydrographic and fish faunal history of the Great Basin. Finally, where possible, data on the history of California lagoons are to be obtained for the purpose of comparison with data already available on Batiquitos Lagoon, California.

SUPPORTED BY U.S. National Science Foundation

7.0158, THE POSTPLEISTOCENE OCEANOGRAPHY AND BIOLOGY OF THE EASTERN NORTH PACIFIC

J.D. ISAACS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

As a result of intense oceanographic and marine biological studies particularly in the last 15 years, the eastern North Pacific is one of the best known and best understood oceanic regions on earth. Knowledge and understanding of part of this region (the California Current System, per se), ranks as one of the most complete in the world. In a major part, this stems from some 22,000 oceanographic and biological stations occupied in the last 15 years by the California Cooperative Oceanic Fisheries Investigations of which the Marine Life Research Program of the Scripps Institution of Oceanography is a major component. Also, broader pertinent understanding has been derived from many other expeditions and studies in the Pacific. These studies are continuing.

The present understanding of the biology, oceanography, and climatology of the eastern North Pacific is of sufficient depth that it undoubtedly will be possible to reconstruct major events of eastern Pacific history in the last several millenia from documentary and sedimentary records. The proposed study will consist of an effort to reconstruct several thousand years of the recent oceanographic, climatological and biological history of the eastern North Pacific from all available records.

SUPPORTED BY U.S. National Science Foundation

7.0159, INVESTIGATION OF QUATERNARY SEA LEVEL CHANGES IN THE CAROLINE AND MARSHALL ISLANDS

W.A. NIERENBERG, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The object of this study is to investigate evidence for a postglacial high sea level stand that is reported from the Southwest Pacific. This evidence conflicts with many investigations from both sides of the Atlantic where carbon-14 dates indicate rapid postglacial sea level rise followed by a gradual rise to the present level. The Caroline and Marshall Island areas have been chosen for the study because reports of their uniformly submerged 15-18 meter benches appear to indicate stability; borings in Eniwetok show recent coral growth above these platforms, probably extending slightly above present sea level; the reefs provide excellent material for dating; and there are many reports of plus 2 meter benches on the islands. The plan would involve two months of field investigation in the area on a Scripps Institution ship. The work would combine sounding lines, continuous reflection profiling, dredging, shallow drilling, measurement of distribution and standing crop of growing corals by Scuba-diving on submarine terraces, and subsequent analyses and dating of selected samples. It is hoped that the study will reveal (1) whether these island masses have actually been stable, (2) the age and origin of the submerged platforms, and (3) will test the validity of the supposed postglacial coral growth above present sea level.

SUPPORTED BY U.S. National Science Foundation

7.0160, RADIOLARIA IN SEDIMENTS

W.R. RIEDEL, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The objective is to study the Tertiary history of the Radiolaria and apply the results to the interpretation of deep Pacific sediment cores. The paleo-distribution of fossil organisms in cores is compared with bathymetric, geological, and geophysical observations. The system of classification of the organisms is also continually modified to reflect the evolutionary relationships of the various species. During the coming year, attention will be concentrated on this aspect of the work. Cores from NOVA expedition now in progress will be studied.

This program will provide (1) supporting information for studies of the physical, chemical, and biological properties of ocean-bottom sediments and of the processes and factors which control them, and (2) supervision in the storage, description, record keeping, indexing, and distribution of the Scripps core collection.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0161, PALEOTEMPERATURE RESEARCH

C. EMILIANI, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

Within the framework of oxygen isotope geochemistry, the proposed research program has four major goals: 1) to determine the depth habitats of Tertiary pelagic Foraminifera 2) to continue Paleotemperature analysis of JOIDES (Blake Plateau) drill cores J-3, J-Y, and J-6 3) to begin Paleotemperature analysis of Pleistocene cores from the southern hemisphere 4) to continue and extend spectral analysis to Tertiary sections of cores from Blake Plateau.

SUPPORTED BY U.S. National Science Foundation

7.0162, FLORIDA CORAL REEF STUDIES

H.G. MULTER, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

The proposed research deals with certain Florida coral reefs, their biological make-up, areal extent, relationship to rocks on the mainland, and particularly their place in the geologic evolution of south Florida. This work is an extension of studies carried out under GP-5250. In order to better understand the sequence of events and environmental conditions that led to the formation of the Florida Keys, the Atlantic Coastal Ridge of the mainland of Florida, and the Everglades of south Florida, it is necessary to obtain additional information relating to the rock foundation underlying the living coral reef tract, the rock formation beneath Florida Bay, and the linear extent of the Key Largo limestone west of Key West.

It is therefore planned to drill several core holes to obtain subsurface information relative to these problems. One series of holes will be drilled from the outer edge of the living reef across the width of the reef-flat toward the keys in order to obtain information on the back-reef and fore-reef relationships. Drill cores will also be taken in the Florida Bay to determine the nature of the substrate on which the soft bottom sediments lie. These data should help bridge the gap between the keys and the mainland. Additional holes west of Key West will provide information relative to the base on which the line of keys west of Key West have formed.

The proposed study is expected to further our understanding of the arcuate Key Largo reef which was the major control for late Pleistocene sedimentation in south Florida. Of broader significance, the research will have a particular bearing on reconstruction of major events in the geologic history of the younger Pleistocene of south Florida.

SUPPORTED BY U.S. National Science Foundation

7.0163, THE SEDIMENTARY AND DIAGENETIC RECORD OF ENVIRONMENTAL PARAMETERS IN RECENT BAHAMIAN TIDAL FLATS

R.N. GINSBURG, Johns Hopkins University, Graduate School, *Baltimore, Maryland* 21218

In view of the importance of the sedimentary record to the interpretation of the past history of the earth's surface and the geochemical evolution of the atmosphere and oceans, it is of utmost importance to know which environmental parameters leave their record in sediments and how precisely variations in these parameters are reflected in sedimentary and diagenetic features. To determine what information about the activity of living organisms, water chemistry, tidal ranges, weather and climate are recorded in the sediments it is proposed to study the Recent tropical tidal flat environment. This environment was chosen for study because it has been established to be a major contributor to the sedimentary record throughout geologic time, especially in the Precambrian and lower Paleozoic eras. The same suite of sedimentary features (laminations, thin bedding, mud cracks, intraformational breccias, algal stromatolites, abundance of dolemite) that are so characteristic of the earliest carbonate rocks in the geologic record have recently been discovered in modern tropical tidal flats, making such tropical areas primary targets for this type of research. The proposed study will provide a calibration for more precise interpretation of environmental parameters operating during deposition of those vast thicknesses of ancient tidal flat deposits.

SUPPORTED BY U.S. National Science Foundation

7.0164, GEOLOGICAL STUDIES IN NORTHERN LAKE MICHIGAN

J.L. HOUGH, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan*

Northern Lake Michigan is the locale of several unsolved problems pertinent to the bedrock geology of the region and to the postglacial history of the lake. Most of the existing geological knowledge of the area stems from land-based exploration and drilling; most of the critical areas are offshore and, prior to the existence of properly equipped research vessels, could not be examined. Suitable research ships are now available and, aided by underwater photography, television and scuba diving, offer promise of solution of hitherto insoluble problems.

Two aspects of postglacial geology to which this research may make new contributions are (1) the altitudes and areal extent of submerged shorelines of old lake stages, in the area which has undergone postglacial upwarp, and (2) the depth and nature of sedimentary deposits now occupying depressions in the lake basin left at the recession of the last glaciation. Previous work in the southern and central parts of the lake, which have not undergone upwarp indicates that submerged shorelines can be traced and that seismic profiles and long core samples yield useful information of postglacial events.

SUPPORTED BY U.S. National Science Foundation

7.0165, PLEISTOCENE OCEANOGRAPHY AS RECORDED IN DEEP SEA SEDIMENT CORES

D.B. ERICSON, Columbia University, Graduate School, *Palisades, New York* 10964

The research to be accomplished is to comfirm the reality of the faunal record from the Pacific by cross correlation, and to work out a chronology of climatic events in the Pacific region in order to establish the relationships between synchronous events in the Pacific and the Atlantic.

A better understanding of this difference between the temperature regimes of the two oceans during the Pleistocene may be expected to bring us closer to a real understanding of the causation of the ice ages.

Evidence in several cores from the equatorial and southern Pacific strongly suggests that the sequence of temperature changes of near surface waters of the Pacific during the late Pleistocene differ markedly from that of the North and equatorial Atlantic. The evidence as it now stands indicates that the temperature changes of the Atlantic as recorded in the sediments were brought about by the ice sheets on the adjacent continents, whereas those of the Pacific were directly due to variations in radiant energy from the sun. It seems that the curve of temperature variation in the Pacific follows the pattern postulated by G.C. Simpson, who developed the hypothesis that ice ages were due to increased precipitation in high latitudes brought about by greater evaporation from the equatorial waters of the oceans, in consequence of larger output of radiant energy from the sun.

SUPPORTED BY U.S. National Science Foundation

7.0166, A PALEOMAGNETIC STUDY OF TERTIARY AND PLEISTOCENE OCEANIC CORES

N.D. OPDYKE, Columbia University, Graduate School, *Palisades, New York* 10964

It has already been shown by the principal investigator that certain oceanic cores faithfully reflect the reversal history of the earth's magnetic field during the last 3.5 My. It is proposed to extend this work as far back in time as is feasible. In cores with low sedimentation rates it should be possible to extend this stratigraphy to the Miocene Pliocene boundary. In order to extend the study even further into the past it will be necessary to use cores which contain overlapping sections.

During the early months of 1966 research was begun at Lamont Geological Observatory on the paleomagnetism of deep-sea cores. Work has already been completed on cores from the circum-Antarctic region and from the North Pacific basin. We have found that unoriented piston cores from high and intermediate latitudes preserve a record of the changes in polarity of the earth's magnetic field. Previously reversals have been reported in short gravity cores from the Pacific Ocean and from the experimental Mohole core.

Because the time of these reversals of polarity is now known for the last 3.5 My. it is possible to use the magnetic stratigraphy to attack many problems in oceanography.

SUPPORTED BY U.S. National Science Foundation

7F. PALEONTOLOGY

7.0167, PALEONTOLOGICAL EVIDENCE OF CYCLES IN THE EARTH-MOON SYSTEM

W.B. BERRY, Univ. of California, Graduate School, *Berkeley, California* 94720

Technical Objective. To study past history of the Moon through studies of the length of day and month compared with a year by relationship of marine invertebrate shell growth to environmental cycles; interpretations of growth layers in fossil shells.

Approach. Continuation growth experiments and study of fossil shells in thin section. Marked specimens observed in natural environment for 18 months; study of marginal increments and frequency distribution of naturally occurring 'wild' samples applied to interpretation of growth layering patterns seen in fossil shells.

Progress: Comparison of marginal shell increments with seasons of the year gave evidence of annual growth for several Venerid species in colder temperate waters. Annual layers are distinguishable from erratic growth rings reflecting disturbances such as temporary burial or removal from water; annual layers more distinct in shells of cold water species. Gain in evidence that shell growth reflects annual fortnightly and diurnal variations in environment.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

7.0168, TAXONOMY AND STRATIGRAPHY OF CALCAREOUS NANNOPLANKTON IN MARINE SEDIMENT SEQUENCES

W.R. RIEDEL, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

Calcareous nannoplankton (coccoliths, discoasters and similar forms) have been shown to be very useful for precise stratigraphic correlations of marine strata. There remain, however, considerable segments of geologic time, and large areas of the world, for which there is no published information on these nannofossils. It is proposed to work on the calcareous nannoplankton in critical submarine and land- based sediment sequences with a competent (preferably foraminiferal) stratigrapher as a co-worker. In this manner, the stratigraphy of the nannoplankton can be related to results from the Radiolaria and Foraminifera, and a rather comprehensive interpretation of the stratigraphical paleontology of pelagic sediments will result.

SUPPORTED BY U.S. National Science Foundation

7.0169, STRATIGRAPHY AND PALEOECOLOGY OF FOSSIL SILICOFLAGELLATES FROM ANTARTIC DEEP-SEA CORES

Y.T. MANDRA, San Francisco State College, Graduate School, *San Francisco, California* 94132

Brief Description of Research Project: San Francisco State College proposes to carry out comprehensive research of fossil silicoflagellates from Antarctic deep-sea sediments. Silicoflagellates have been investigated in a very few marine sedimentary formations on land where their value for correlation and interpretation of paleo-ecology has been shown. Almost no research has been done on silicoflagellates from deep-sea sediments. The project would include a study of the tops and bottoms of approximately 70 selected cores collected during cruises of the USNS Eltanin. This would allow a determination of the age range of each core in relation to silicoflagellate stratigraphy. Approximately 300 selected samples from these cores, representing zones recorded as having a high content of silicious material, would be processed for the separation of their contained silicoflagellates from other silicious microfossils.

Two genera of silicoflagellates, Dictyocha and Distephanus, have been shown by the principal investigator to be temperature sensitive. He has developed a technique using the ratios of the frequencies of these two types to determine the temperatures of ancient seas. This project would apply this technique to deep-sea cores for the first time. The works of Watkins at Florida State University and Hayes at Lamont Geological Observatory have shown a positive correlation with other organisms and magnetic reversals. Of particular significance would be the correlation of extinction and appearance of genera and species of silicoflagellates in relation to magnetic reversals.

This program does not involve any work on the USNS Eltanin.

SUPPORTED BY U.S. National Science Foundation

7.0170, MIOCENE FISHES AND FISH FAUNAS AS DETERMINED FROM A STUDY OF FOSSIL OTOLITHS

J.E. FITCH, State Dept. of Fish & Game, *Terminal Island, California*

The California Miocene is extremely rich in teleost (bony fish) remains, particularly otoliths, but to date the only faunas known are based upon skeletal material and upon scales embedded in Miocene diatomites and shales. A primary objective of this proposed study is to collect, identify, describe and illustrate the Miocene teleost fauna represented by otoliths. Secondary objectives would include: (i) determining palaeoecology by comparing Miocene faunal assemblages with those of today to see if logical conclusions can be reached, (ii) comparing Pacific coast Miocene families and genera with those from the Atlantic and Gulf coasts to see if deductions can be made regarding zoogeography, affinities, and migrations, and (iii) determining if fish faunas from various deposits represent normal seasonal mortalities or catastrophic die-offs. (These data can be obtained by examining otoliths for indications of digestive action resulting from ingestion by predator species, and by noting marginal zones in those otoliths which have retained annual growth characteristics.)

SUPPORTED BY U.S. National Science Foundation

7.0171, LIVING AND FOSSIL ZOOPLANKTON, AND RELATED PROBLEMS OF PALEOLIMNOLOGY

E.S. DEEVEY, Yale University, Graduate School, *New Haven, Connecticut* 06520

The research will encompass the following: 1. Quantitative studies of fossil Cladocera, especially Bosmina species, are to be conducted in sediment cores from New England and New Zealand lakes in which living populations are also being studied. More than 14,000 years of quantitative record is available in Rogers Lake, Connecticut. The New Zealand sections provide various kinds of control, the climatic history having been similar while the biotic diversity is lower. The possibility is being tested that certain species-substitutions are related to size-specific predation. 2. Population studies of zooplankters are planned under controlled conditions of temperature and food supply. The chief item needed for interpretation of fossil assemblages is information on instar length and number in Bosmina, but the plan is to attack the more general problem of niche diversification via cyclomorphosis. 3. Ionic regulation is to be examined in entomostracans of inland waters, especially in the remarkable copepod family Centropagidae, which has important geochemical and zoogeographic implications. 4. Studies of meromictic (and sulfate-rich) Green Lake, New York, will be examined. Because of absence of benthic animals, this lake is suitable for analysis of stratigraphic smearing of microfossils below the mudwater interface. It is proposed to sample the lake and study the problem of smearing. 5. Finally, certain aspects of tropical paleoecology will receive continued attention.

SUPPORTED BY U.S. National Science Foundation

7.0172, INVESTIGATIONS ON THE CRUSTOSE CORALLINES OF THE NORTH ATLANTIC

W.H. ADEY, **Smithsonian Institution, *Washington, District of Columbia* 20560**

Collection of crustose corallines by SCUBA-diving and with an underwater research vehicle from the coasts of the entire North Atlantic, to study their systematics, biogeography, ecology and sedimentology, and to develop a North Atlantic monograph for the group.

SUPPORTED BY Smithsonian Institution

7.0173, EVOLUTION OF PROVINCIAL DISTRIBUTION PATTERNS IN CHEILOSTOME BRYOZOA

A.H. CHEETHAM, **Smithsonian Institution, *Washington, District of Columbia* 20560**

Seemingly high endemicity at both generic and specific levels in Late Cretaceous and Tertiary cheilostome Bryozoa is being studied. Samples now on hand will be supplemented by collecting especially in areas bordering the North Atlantic. Interpretation of the response of benthic and epi-planktonic cheilostome groups to shifting barriers and corridors will be made.

SUPPORTED BY Smithsonian Institution

7.0174, LA JOLLA MARINE GEOLOGY LABORATORY

G.W. MOORE, **U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242**

Liaison with Bureau of Commercial Fisheries, Scripps Institution and other oceanographic agencies in the area. Electron and light microscope identification of micropaleontologic floras for age and ecologic determinations.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0175, BIOFACIES STUDY OF BENTHONIC FORAMINIFERA IN OCEAN SEDIMENT CORES

W.D. BOCK, **Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124**

Benthonic species of Foraminifera from core material obtained during the 1968 JOIDES drilling program will be studied for morphological variation through time to determine the paleoecological conditions of the time sequence represented in each core. The ultimate goal of the study will be to establish a 3-dimensional distribution of single species in the geologic record. In addition, it may be possible to discern boundary conditions for reproductive rates at low temperatures.

SUPPORTED BY U.S. National Science Foundation

7.0176, CALCAREOUS NANNOFOSSILS FROM PALEOCENE - EOCENE DEPOSITS

S. GARTNER, **Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124**

Paleocene - Eocene calcareous nannofossils have been intensively studied during the past decade, and several partial nannofossils zonations have been proposed for this stratigraphic interval. Most previous studies, however, have been on isolated samples or on sections covering limited intervals, so that the nearly complete Paleocene - Eocene interval penetrated by JOIDES coreholes 3, 4, and 6 offers a unique opportunity to test previous zonations, to modify and supplement them; and to establish a reference standard for this interval for future study of early Tertiary oceanic sediments. This opportunity will be exploited.

SUPPORTED BY U.S. National Science Foundation

7.0177, STUDY OF FOSSIL SEA TURTLE COLLECTION AT THE INSTITUT ROYAL DES SCIENCES NATURELLES, BRUSSELS, BELGIUM

R. ZANGERL, **Field Museum of Nat. History, *Chicago, Illinois* 60605**

The late Cretaceous and Tertiary strata of Belgium have produced what is thought to be one of the finest collections of fossil sea turtles in existence. Louis Dollo, the dean of vertebrate paleontologists of Belgium, is largely responsible for this collection, and he intended to work it up. But this never happened, and the collection has remained unstudied since early in the century. A few years ago, Dr. Casier (a paleoichthyologist) worked on some of the skull material but has not yet published. He will be coauthor of the present effort.

The Belgian material is most important because much of the material is very well preserved (whole skeletons). It is hoped that the Eocene specimens will shed light on the London Clay forms, well described by Richard Owen, but in need of revision. A correspondent in England is currently working on the British materials and an exchange of information is planned at the end of the principal investigator's stay in Brussels.

SUPPORTED BY U.S. National Science Foundation

7.0178, STRATIGRAPHIC STUDY OF RADIOLARIA IN DEEP SEA QUATERNARY SEDIMENTS

C. NIGRINI, **Northwestern University, Graduate School, *Evanston, Illinois* 60201**

Recent research has shown that is is possible to distinguish between low, middle and high latitude radiolarian assemblages. It is now proposed to use this knowledge in the interpretation of Quaternary stratigraphy, using deep-sea core material from selected localities in the three major ocean basins. Radiolarian sequences, correlated with similar foraminiferal series, would allow an extension of deep- sea Quaternary stratigraphy into non-calcareous sediments. The study will be based on cores already in the collections of Lamont Geological Observatory and Scripps Institution of Oceanography. Support is requested for the principal investigator, and for the purchase of some supplies and equipment.

SUPPORTED BY U.S. National Science Foundation

7.0179, NORTH AMERICAN POST-OLIGOCENE CYTHERID OSTRACODS

P.A. SANDBERG, **Univ. of Illinois, Graduate School, *Urbana, Illinois***

This study is underway on the systematics, morphology, ontogeny, distribution, and ecology of North American Late Cenozoic and modern brackish water cytherid Ostracoda. Abundant preserved material collected from coastal waters is now available. Preliminary results indicate that along the Atlantic coast the ostracods of modern low salinity environments and ancient facies interpreted as deposited in low salinity environments are really much more like those of the Gulf Coast than was previously believed. Confusing phylogenetic and taxonomic problems involving morphologically very similar, congeneric species, particularly of the common genera Cytherura and Porissocytheridea, have been worked out. Frequently, solution of the problems was facilitated by presence of differing modes of ontogenetic development in species with very similar adult forms.

The detailed information on morphology and ontogony of the ostracods will be utilized in further recognition and elucidation of phylogenetic trends within and between the various genera.

SUPPORTED BY U.S. National Science Foundation

7.0180, MEASURING PAST OCEANOGRAPHIC CONDITIONS

J.R. DODD, Indiana University, Graduate School, *Bloomington, Indiana* 47405

Skeletal microstructure, trace chemistry, and mineral composition of some invertebrate skeletons are affected by the temperature and salinity of the sea water in which they grow. Work on some species indicates that from these relationships determination of temperatures and salinities of the geologic past is possible by analysis of fossils. More work needs to be done to make these techniques generally applicable.

A series of experiments utilizing radioactive tracers (especially Calcium-45 and Strontium-85) is underway. These experiments are designed to determine variation with environmental parameters of calcification rate in the total skeleton and in various parts, the relative rate of calcite to aragonite deposition in the skeleton, and the rate of uptake of various trace constituents (especially strontium). It is hoped to determine the variation in these rates with temperature and salinity and perhaps other parameters.

SUPPORTED BY Amer. Chemical Society

7.0181, COMPARATIVE STUDIES OF LATE MESOZOIC AND EARLY CENOZOIC HERPETOFAUNAS

R. ESTES, Boston University, Graduate School, *Boston, Massachusetts* 02215

This investigation is a continuation of the research initiated under NSF grants G-18905, GB-1683, and GB-4304.

The evolutionary and faunal history of the American herpetofauna is little known. Few useful fossils are available and many are unpublished. The work involves study of a series of geographically and temporally associated fossil samples in midcontinent North America. These samples come from similar depositional environments and span approximately 100 million years of geologic time. Preliminary studies indicate presence of a widely-distributed, coastal plain herpetofauna, which once lived on the shores of North American epicontinental seas. Strong resemblance to elements now South and Central American occurs in the lizards and other terrestrial forms, while the aquatic fish and amphibian fauna shows closest resemblances to the present-day coastal plain fauna of the Gulf Coast of North America. Comparisons of this fauna to similar forms in Europe has disclosed little similarity between the two continents during the period studied, mainly from Late Jurassic to Early Cenozoic time. Real similarities are perhaps more likely to emerge in comparison with South American fossils. After continued study of American, European, and South American materials is completed, a more consistent picture of the evolutionary and faunal changes involved will be available than exists at present.

SUPPORTED BY U.S. National Science Foundation

7.0182, STRATIGRAPHIC AND TAXONOMIC-PHYLOGENETIC STUDIES ON PLANKTONIC FORAMINIFERA

W.A. BERGGREN, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

It is planned to investigate the planktonic foraminifera and their use in formulating a unified mondial biostratigraphic zonation for marine Cretaceous and Tertiary rock units. The framework for this investigation will be detailed analysis of the planktonic foraminifera of the type sections of the Cretaceous and Tertiary stages, which are located in western Europe. The program will involve several methods of study including: detailed biostratigraphic investigations of selected stratigraphic sequences in North and South America, western Europe, eastern Europe, North Africa, Asia Minor and Oceania; and detailed structural analysis of the planktonic foraminifera using the electron microscope, x-rays, peel-replicas and similar methods. It is planned to integrate the program with the JOIDES deep sea coring program.

SUPPORTED BY U.S. National Science Foundation

7.0183, ELECTRON MICROSCOPY OF CALCAREOUS AND SILICEOUS PLANKTON FOR PALEOECOLOGIC AND PALEOCLIMATIC STUDIES

A.W. BE, Columbia University, Graduate School, *Palisades, New York* 10964

This if for the continuation and expansion of present work to include electron microscopic studies on the taxonomy, zoogeography and ecology-paleoecology of Bacillariophyta, Coccolithophoridae, and foraminiferal shell structure in ocean waters and marine sediments.

This work is a tripartite investigation using the facilities of the Lamont electron microscope laboratories.

SUPPORTED BY U.S. National Science Foundation

7.0184, A MICROPALEONTOLOGICAL STUDY OF DEEP-SEA CRETACEOUS AND TERTIARY SEDIMENT

M. EWING, Columbia University, Graduate School, *Palisades, New York* 10964

The objectives of this study are: (1) to identify and describe Cretaceous and Tertiary microfossil assemblages (foraminifera, radiolaria, diatoms and coccoliths); (2) to investigate the past distribution and ranges of microfossil species; (3) to study the relation of the physical properties of the sediments to the flora and fauna; (4) to relate these cores to reflecting horizons on seismic profile records and to map the distribution of pre-Pleistocene sediments on portions of specific topographic highs (e.g. Mid-Atlantic Ridge, East Falkland Plateau and East Pacific Rise).

From a preliminary study of the pre-Pleistocene cores, it is evident that on certain areas of ocean floor pre-Pleistocene sediments are within reach of the corer. These localities are: (1) the northern scarp and crest of the Rio Grande Rise; (2) the top of the East Falkland Plateau; (3) the rugged crest and steep flanks of the Agulhas Plateau; (4) the top and flanks of the northeastern end of the Walvis Ridge; (5) the steep flanks of some equatorial fracture zones; (6) an outcrop area of the prominent seismic reflector layer A, northeast of the Bahamas.

SUPPORTED BY U.S. National Science Foundation

7.0185, PALEONTOLOGY OF LATE CENOZIC ANTARCTIC RADIOLARIA AND DIATOMS

J.D. HAYS, Columbia University, Graduate School, *Palisades, New York* 10964

Several hundred deep-sea cores from the Southern Oceans, off Antarctica, have been studied by Lamont Geological Observatory for their contained radiolaria and diatoms. Systematic and stratigraphic studies of these planktonic, silica-covered protista, combined with radiometric dating and paleomagnetic polarity measurements, have led to the establishment of a precise stratigraphic sequence covering the last five-million years. Correlation of the radiolarian zones with radiometric dates and paleomagnetic-episode boundaries has shown that the faunal boundries are isochronous in sediments covering large areas. This permits the detailed determination of rates of sedimentation and other aspects of the late geologic history for large areas of the Antarctic Ocean floor. Studies of recent and fossil diatoms have indicated cold-water and warm-water species, whose paleodistribution indicates the shifting position of the Antarctic Convergence and, indirectly climatic changes. The project will continue to examine the siliceous-microfossil content of cores taken by the Eltanin and the Glacier for continued refinement of the radiolarian and diatom zones and for the extention of these zones and related conclusions into the areas to be sampled during the next year.

No personnel from this project will be on the Eltanin or the Glacier.

SUPPORTED BY U.S. National Science Foundation

7.0186, MODERN FORAMINIFERA OFF OREGON

G.A. FOWLER, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

The object of the proposed study is to make a detailed examination of the foraminifera from the sea floor off the coast of Oregon. This is an almost unexplored area from the standpoint of foraminiferal ecology. Findings are expanding and augmenting existing knowledge from this and other parts of the world. Results of current investigations demonstrate considerable variation in data from three discrete samples at each station and between closely spaced profiles in the shelf. It is important to determine to what extent the variance of faunal trends occurs. Sufficient samples for this have been obtained already and are partially processed. One year is needed to complete the study.

SUPPORTED BY U.S. National Science Foundation

7.0187, STUDY OF RADIOLARIA IN SURFACE SEDIMENTS OF THE NORTHEAST PACIFIC OCEAN

H. LING, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

Literature related to or mentioning the occurrence of Radiolaria in the Northeast Pacific indicates that this micro-organism is one of the most abundant, widely distributed, and persistent biogenic elements in the surface sediments of the Northeast Pacific Ocean. Yet, no detailed study of Radiolaria from this area has previously been attempted.

The principle objective of this study will be to carry out a taxonomic study of Radiolaria in approximately 50 surface sediment samples from the Northeast Pacific Ocean that are part of the sediment collection of the Department of Oceanography, University of Washington. The taxonomic study is a necessary initial step in a more comprehensive study, to be attempted later, of the relative abundances of the defined taxa in assemblages and the distribution of the fauna in areas of warm mass properties, bathymetry, and nature of sediments.

SUPPORTED BY U.S. National Science Foundation

7G. SEDIMENTOLOGY - STRATIGRAPHY

(origin, Deposition, and Properties of Ocean Sediments; Studies ofSubbottom Sedimentary Rocks. See Also Chapters 7c and 8n.)

7.0188, INTERSTITIAL WATER OF GLACIAL-MARINE SEDIMENT

C.M. HOSKIN, Univ. of Alaska, Graduate School, *College, Alaska* 99735

The problem to be investigated is concerned with (1) the amount and salinity of pore water in glacial-marine sediment, and (2) the nature of the transition from a fresh water environment at the glacier terminus through the estuarine conditions in glacier bays to a normal marine environment. The expected results will be quantitative data to be used for a first evaluation of any possible potential for production of subsurface water from these glacial-marine sediments. Gravity cores will be taken in the recent sediments of the glacier bay district of Southern Alaska. Coring will be done on traverses from glacier terminus through the estuary to the normal open marine. Research vessels and laboratory facilities of the Marine Institute of the University of Alaska at Douglas will be used for the field work. Laboratory work in College, Alaska, will be concerned with measurements of content and salinity of pore water, and porosity, permeability, and grain size of the sediment. Water content will be determined by centrifugation. Salinity of the pore water will be done by titration with silver nitrate using potassium dichromate as the end-point indicator. Porosity (pycnometer and calculation) and permeability (constant and variable head permeameters) determinations will be made with methods now in use by the Hydrologic Laboratory of the United States Geological Survey at Denver. Grain size analysis will be made by Tyler ro-tap for sand and by pipette for silt and clay. Mineralogic composition of the sediment will be determined by standard petrographic techniques.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Alaska

7.0189, SEDIMENT AND VOLCANIC STUDIES

Y.R. NAYUDU, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735 (NONR)

The objective of this task is to determine distributions of sediments throughout the northeast Pacific Ocean as they were deposited during and since the Pleistocene ice ages. Core and dredge samples will be obtained on ships, and the samples will be analyzed in the laboratory to determine their stratigraphy, petrology, and origin. Methods of analysis include chemical, optical, x-ray diffraction, spectroscopic, trace-element, and conventional particle size distribution. Submarine volcanism is being studied by means of petrographic analyses of volcanic dredge samples. Leaching of submarine basalt flows has been shown to result in concentrations of manganese nodules. Studies are being continued on this formation of manganese nodules.

These investigations provide information on the distribution and rate of deposition of sediments deposited in the Northeast Pacific Ocean during Pleistocene and recent times. Determinations on the origins of these sediments makes possible reasonable estimations of sediment layering in portions of the northeast Pacific not yet surveyed.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0190, SEDIMENTARY GEOCHEMISTRY

G.D. SHARMA, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

This investigation pertains to the study of authigenic minerals found in the sea water. Various chemical species when added to synthetic sea water precipitated amorphous minerals. The effects of relative concentrations of the species added and the nature of the precipitate is currently underway.

SUPPORTED BY Union Oil Company of California

7.0191, SUBMARINE GEOLOGY OF GASTINEAU CHANNEL JUNEAU, ALASKA

G.D. SHARMA, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

The primary aim of this study was to determine the nature and thickness of sediment in the Gastineau Channel. A Bolt pneumatic continuous profiler was used to determine the sub-bottom structure in the channel. Three longitudinal and twelve traverse profiles were obtained. Nearly fifty bottom grabs and a few cores were obtained to determine the nature of sediments.

The size parameters of these bottom grab samples were computed from weight percentages determined by wet sieving and pipette analyses. The sediments in Gastineau Channel were predominantly silt with varying components of sand and clay. Near shore sediments were sand with minor fractions of pebble and cobbles. The thickness of sediments in the channel varied from zero to approximately 450 feet. The channel consisted of a shallow basin near Juneau bounded by a sill near Juneau Island. Southeast of the sill the channel deepened gradually and thickness of sediment increased more and there were no sediments on the sill.

SUPPORTED BY Global Marine Incorporated
University of Alaska

7.0192, DIAGENESIS IN SEDIMENTS

G.D. SHARMA, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

Diagenic alterations were induced in sediments in a model representing shallow marine shelf deposits by injecting synthetic sea water under partial pressure of carbon dioxide. The sediments from the model were then removed and studied under a petrographic microscope. This study has included the interrelation of the chemistry of the interstitial fluid and the mineralogy of the sediments, the factors controlling the formation of silica and calcite cements, the processes responsible for transforming sediments into hard rocks, and the sequence of these processes.

The petrographic analyses indicate that during early diagenesis cements form in the intergranular spaces only. The calcite cement crystallized as small fibrous crystals around the grains, and extends into the pore space subsequently resulting in rim cementation. Further studies to delineate the sources of the cements and the chemical environment of their precipitation are currently underway.

SUPPORTED BY Amer. Chemical Society

7.0193, SEDIMENTOLOGY AND GEOLOGIC HISTORY OF HUMBOLDT BAY, CALIFORNIA

R.W. THOMPSON, Humboldt State College, Graduate School, *Arcata, California* 95521

This is a basic research project with the following principal objectives: 1) To assess the physical characteristics of bottom sediments in the various morphologic environments of Humboldt Bay and the immediate surroundings; 2) To account for these characteristics in terms of physical, chemical and biological processes acting in the bay; 3) To apply the information gained in 1) and 2) toward interpretation of sediments encountered in borings beneath the bay and surrounding environs, and finally - 4) To work out the recent geological history of bay development.

SUPPORTED BY Amer. Chemical Society

7.0194, RADIOISOTOPIC SAND TRACER STUDY, POINT CONCEPTION, SANTA BARBARA COUNTY, CALIFORNIA

J.R. TEERINK, Univ. of California, Graduate School, *Davis, California* 95616

Problem: There is a need for an investigation of the littoral material movement around headlands along the California coastline in order to improve capabilities in the planning, design, construction and maintenance of coastal works.

Solution: The U. S. Atomic Energy Commission and all participating agencies, including the Department of Water Resources, accepted and approved a proposal to investigate the mechanics of littoral transport around Point Conception, California, by tracing sand grains tagged with radioisotopes.

Following site selection, preliminary tests were made of several isotopes and a tracer meeting engineering, scientific and health requirements was selected. Minor changes in instrumentation and improvements in the field techniques were developed. Results obtained from the first year's study were encouraging. The basic tools are now available to meet several of the study program objectives, i.e., tracing material around a headland and qualitative mechanics of transport.

SUPPORTED BY California State Government
U.S. Dept. of Defense - Army
U.S. Dept. of Defense - Navy
U.S. Atomic Energy Commission
U.S. Natl. Aero. & Space Adm.

7.0195, INDIAN OCEAN FORAMINFERA AND SEDIMENTS

O.L. BANDY, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

Primary emphasis will be given to the completion and publication of the following studies: (1) sedimentology of the Andaman Sea by Kelvin S. Rodolfo, (2) foraminiferal biofacies of the Andaman Sea by William E. Frerichs, (3) sedimentology of a profile across the Mozambique Channel by Douglas Sherman and Donn Gorsline, (4) foraminiferal biofacies of the southwestern Indian Ocean by Edith Vincent, and (5) ecophenotypic studies of selected foraminiferal species by Orville L. Bandy, William E. Frerichs, and Edith Vincent. Sedimentology of the Andaman Sea will be completed by September, 1966; foraminiferal biofacies of the Andaman Sea could be completed by about March 1967; sedimentology of a profile across the Mozambique Channel will probably be completed by the end of September; foraminiferal biofacies of the southwestern Indian Ocean will be completed by September, 1967; and a series of ecophenotypic investigations will be completed during the coming year.

During Cruise 17 of the R/V ANTON BRUUN in the summer of 1966, a valuable series of bottom samples were collected off South America in the region of the Nasca Ridge. It is planned to make comparisons of benthic zonation, species variation, and foraminiferal ecology between the Indian Ocean and those populations collected in the current Bruun program.

SUPPORTED BY U.S. National Science Foundation

7.0196, SAND RIPPLES

R.O. STONE, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

A study is being made of sand ripples, as a major form of sediment movement under both suaorial and subaqueous conditions. Using cameras and other equipment, measurements are being made of relevant properties, such as structure, size, shape, rate of movement, and ages; and forces, such as wind and current velocity, wave characteristics, and sediment abundance. Analyses are being made to identify significant variables, thresholds and mechanisms of movement, and the degree to which ripples are indicators of other beach and near-shore environmental conditions.

A better understanding of sediment movement in the near-shore and beach zones is directly applicable to naval problems. This study may also lead to ability to predict local environmental conditions through remotely sensed or otherwise acquired information on sand ripple characteristics.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0197, (U) THE EFFECTS OF OCEANIC PROCESSES ON THE DEPOSITION OF RIVER SEDIMENTS

R.J. GIBBS, Univ. of California, Graduate School, *Los Angeles - U.C.L.A., California* 90024

Objective: An increased ability of the Navy to plan and carry out the operations involving ocean-bottom engineering, subsurface search and rescue, and other bottom-influenced activities depends the area of operation. Those properties in turn depend largely upon the age and composition of the sediments and upon the processes by which they have been transported and deposited. This research should provide a comprehensive understanding of these sedimentary parameters on the continental margin off the mouth of the Amazon River and a better understanding of similar processes applicable to other large river systems.

Approach: Material from cores and dredges and samples of suspended sediment-in-transport have been obtained from previous field investigations in the area off the Amazon and will be analyzed in the laboratory for their composition, size distribution, and age. The analytical results will be mapped geographically and quantitatively related to similar results which already describe this sedimentary material at its source. From these relationships conclusions will be drawn concerning the rates and types of transportation, deposition, and alteration of the sediments as they move from the mouth of the Amazon River to the deep-sea floor.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0198, DEPOSITIONAL PROCESSES MARGINAL TO LARGE ANTARCTIC ICE SHELVES

C.A. NELSON, Univ. of California, Graduate School, *Los Angeles - U.C.L.A., California* 90024

UCLA will investigate the sedimentology, especially the depositional processes, of modern glacial marine sediments from the Antarctic Ocean near the margins of large ice shelves. Short phleger cores, long piston cores, and dredge samples are available from the Weddell Sea, Ross Sea, and other areas that can be compared in several parameters with extensively investigated glacial marine sediments of Paleozoic age from Antarctica, South America, South Africa, Australia, and India. Such comparisons will be significant in determining the environments of deposition of the ancient deposits about which there have been many theories.

SUPPORTED BY U.S. National Science Foundation

7.0199, QUATERNARY SEDIMENTATION AT MARINE-FLUVIAL INTERFACE, SW OREGON

R.J. JANDA, U.S. Dept. of Interior, Water Resources Division, *Menlo Park, California*

Purpose: To obtain data on the origin and geologic history of Quaternary sediments, including black sands known to contain economically significant heavy minerals.

Methods: Surficial deposits and soils will be mapped in detail and a petrographic study will be made of them. Available drillers' logs and geophysical information will be compiled and supplemented with test drilling where necessary to provide an understanding of the characteristics of the deposits and associated fluids at depth.

Stream gages and sediment sampling sites will be established to provide information for computation of sediment loads. Techniques and equipment for sampling the bed load of gravel bed streams will be developed.

Level surveys, fathometer surveys, and plane table mapping will be used to study changes in beach slope and volumetric changes in estuaries.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0200, SEA FLOOR STUDIES - DEPOSITIONAL AND EROSION PROCESSES

R.F. DILL, U.S. Navy, Undersea Warfare Center, *San Diego, California* 92140

Objective: To determine environmental factors affecting the acoustical uses of the oceans and the stability of structures and equipment emplacement on the sea floor.

Approach: Observe and determine the nature of depositional and erosional processes, especially: (1) those elements affecting the distribution of sediments their transport, accumulation, and lithification. (2) those elements affecting the stability of slopes and bearing capacity. (3) those features and relationships which prove the ability to predict sea floor sediment conditions in ocean areas not yet extensively studied (4) those aspects which affect basic sediment distribution patterns.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0201, DATING MARINE SEDIMENTS

E.D. GOLDBERG, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038 (NONR)

Work continues on investigation of the kinetics of supply of terrigenous components to clastic deep ocean sediments. Aeolian materials in particular are being studied, using direct collection of wind-borne dust for periods of a few days, material trapped in glacier ice (whose geochronology is known) for periods of centuries and fractions, and oceanic cores (dated by Pb-210, K-Ar, and U disequilibrium techniques) for millennia. Wind-transported solids are identified by mineralogy, size analysis, and geometry of ore particles.

Visibility and optical resolution both in the atmosphere and in water bodies are critically dependent on the size and concentration of solid particles that can scatter light. Certain techniques for detection of underwater objects depend on contrast of the object against the background of scattered light. These basic studies will contribute to the knowledge of the character and distribution of light-scattering particles of non-biological origin in the atmosphere and in sea water.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0202, SAND TRANSPORT

D.L. INMAN, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038 (NONR)

The objective is to understand the mechanics of sediment movements by waves, currents, and winds, and hence of formation of sedimentary structures such as beaches and bars. Studies are conducted in the intertidal zones at depths accessible to divers, and in deeper water, especially in submarine canyons, by various means, including deep-sea research vehicles. Studies of flow in submarine canyons continue, with plans for synoptic measurements of the wind field above the water and of currents and pressure in the canyons and on the adjacent shelf. An array of digital wave staffs will measure the onshore flux of wave energy and detect the presence of edge wave modes. Nearshore circulation cells are being studied under controlled conditions in the laboratory and at selected beaches on the Pacific coast, and along the Gulf of California.

The character of nearshore and oceanic sediments and of the wave and current processes by which they are eroded, transported, and deposited is of considerable importance.

This program will contribute significantly to an understanding of nearshore sedimentary processes.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0203, MARINE SEDIMENTS

T.H. VANANDEL, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038 (NONR)

The purpose is to relate ocean sediments to the bathymetry, structure and geological and geophysical properties of the sea floor and to understand the historical and physical processes which determine these relationships. During the coming year, as part of the R/V ARGO cruise around the world, a study will be conducted on the Mid-Atlantic Ridge at about 10 degrees South, using satellite navigation and the shipboard computer to permit planning a reasonable sampling program immediately following the geophysical survey. The work is planned in part to test the theory of seafloor spreading.

This program, in addition to providing much valuable bathymetric and magnetic information, will help provide a predictive capability for extending this information into unsurveyed areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0204, SEDIMENT STRUCTURE

E.L. WINTERER, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038 (NONR)

This research is concerned with modern sediments and ancient sedimentary rocks in tectonically active regions such as the border zones between continents and oceans, and geosynclines, in order to understand the history and structure of these entities and the occurrence, composition, and mechanics of transport of the sediments. During the coming year, bathymetric, seismic and geomagnetic observations and dredge and core samples collected in the Coral Sea during expedition NOVA will be worked up.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0205, MEASUREMENT OF SURFACE CHARGE ON PARTICLES SUSPENDED IN SEA WATER

P.J. WANGERSKY, Dalhousie University, Graduate School, *Halifax - Nova Scotia, Canada*

The purpose of this research was to investigate the nature of the electrostatic surface charge on particulate material, living and dead, suspended in sea water, and to ascertain the effects of this surface charge on the formation of large aggregates from smaller suspended material. This electrostatic charge, expressed as the so-called 'zeta potential', is measured by impressing the rate of movement of particles in this field.

The zeta potentials of a number of living marine organisms largely diatoms, were studied. All of the living organisms displayed zeta potentials around -10 mv in sea water. When the organisms were killed by suspension in liquid nitrogen, their zeta potential went to zero.

Particles made by bubbling air or nitrogen through filtered sea water generally displayed zeta potentials around - 30 mv when re- suspended in distilled water, and around - 10 mv in sea water. As the zeta potential dropped below - 15 mv, clumping of the small particles into larger particles could be seen. Particles formed by swirling or bubbling sea water displayed the same kinds of surface charges as the naturally occurring particles.

SUPPORTED BY U.S. National Science Foundation

7. MARINE GEOLOGY

7.0206, FEASIBILITY OF THE APPLICATION OF PALYNOLOGICAL INVESTIGATION OF DEEP-SEA SEDIMENTS TO MAJOR GEOLOGICAL PROBLEMS

J.J. GROOT, Univ. of Delaware, Graduate School, *Newark, Delaware* 19711

The distribution of pollen and spores in deep-sea sediments is mainly determined by distance from land. At a distance exceeding 350 miles from shore the number of non-reworked pollen is usually too small (less than 10 grains per gram of sediment) for effective palynological study, except where very favorable conditions for dispersal by oceanic circulation exist, as in the Argentine Basin, for instance. The windward or leeward position of sediment samples does not appear to have a significant influence on their pollen content, suggesting that atmospheric transportation is of small importance relative to transportation by currents. Most samples contain some reworked pollen; distinguishing the latter on the basis of stain acceptance cannot be done with certainty at present. The presence of reworked pollen is perhaps the greatest difficulty facing marine palynological research. In view of this difficulty, palynological study should be done in conjunction with other investigations pertaining to the stratigraphy of deep sea sediments. Spectra of non-reworked pollen in deep-sea sediments reflect the vegetation of the neighboring continent and the vertical distribution of these spectra are mainly determined by vegetational and climatic change.

SUPPORTED BY University of Delaware

7.0207, RECENT MARINE AND NONMARINE SEDIMENTS AND MICROFAUNA OF DELAWARE COASTAL AREAS

J.C. KRAFT, Univ. of Delaware, Graduate School, *Newark, Delaware* 19711

It is proposed to study recent sedimentary environments and their associated microfauna as a basis for interpreting the geographic and stratigraphic distribution of similar environments in the geologically recent past. The coastal area of southern Delaware has been selected for study because it contains highly varied shoreline transitional environments which should show distinctive microfaunas, sediments, and sedimentary structures. Knowledge of the interrelations of these modern environments will increase our capability to interpret paleoenvironments.

Specifically it is planned to 1) study the sediment and microfaunal distribution patterns of the shallow-water bays, bay mouth bar, inlet, marsh, and nearshore marine environments, 2) determine what combinations of sediment type, microfaunal occurrence, and sedimentary structures are characteristic of each environment, 3) relate microfaunal distribution to water salinity, temperature variation, and other physical and chemical aspects of the environment, 4) study the nature of the boundaries between the various environments of deposition, and, time permitting, map and interpret the areal distribution of recent sediments of the Delaware Coastal Plain.

SUPPORTED BY U.S. National Science Foundation

7.0208, CHANGES IN SEA LEVEL IN NORTHERN TUNESIA

R.H. BENSON, Smithsonian Institution, *Washington, District of Columbia* 20560

Examination of evidence of sea level in the last 3000 years in the vicinity of Carthage and Utique, Tunesia as shown by changes in coastal sedimentation in relation to archeological sites.

SUPPORTED BY Smithsonian Institution

7.0209, BIOSTRATIGRAPHY OF MID-ATLANTIC RIDGE SEDIMENTS

R. CIFELLI, Smithsonian Institution, *Washington, District of Columbia* 20560

The project involves the study of planktonic Foraminifera from the Mid-Atlantic Ridge. The purpose is to establish the stratigraphic relationships of sediments and other rock types on the Mid-Atlantic Ridge with the goal of determining the time sequence of events in the history of the Atlantic Ocean.

SUPPORTED BY Smithsonian Institution

7.0210, NATURE OF INTERTIDAL EROSION ON CORAL ATOLLS

F.R. FOSBERG, Smithsonian Institution, *Washington, District of Columbia* 20560

An attempt to determine the relative roles of biological agents as compared to such physical ones as abrasion, solution, temperature change, etc., in the intertidal erosion of coral limestone. Involves field studies in collecting of samples of surfaces, and the examination of these by optical microscopy and electron microscope replica photography to see if different surface features can be associated with different erosional agents.

SUPPORTED BY Smithsonian Institution

7.0211, GEOLOGICAL AND HYDROGRAPHIC STUDY OF THE WILMINGTON SUBMARINE CANYON AND ADJACENT AREAS

M. LIGHT, Smithsonian Institution, *Washington, District of Columbia* 20560

A program of investigation has been undertaken by the staff of the Division of Sedimentology, U.S. National Museum, Smithsonian Institution with active cooperation and support of the U.S. Coast Guard Oceanographic Unit, this program has as long-term objective, the detailing of the geometry and sedimentary processes associated with submarine canyons in general. One of the major purposes of this study is the formulation of a sedimentary model for modern canyons located on shelves off low coastal regions which are apparently tectonically stable. The selection of the Wilmington Submarine Canyon for this study was in part determined by logistics, i.e., its proximity to major ports which facilitates repetitive runs over the same area and ease of monitoring with various marine geological and oceanographic techniques.

Thus far four cruises, of 7 days each, have been made to the Wilmington Canyon and adjacent areas. Operations conducted during these cruises included bottom sampling with Boomerang corers and dredges, bottom observations with underwater camera and television instrumentation, sub-bottom seismic profiling, and XBT and STD casts. The next cruise scheduled during February 1969 will include bottom current measurements. Thus far, four papers have been published in various journals. CG Report 373-22, 'Photographic Investigation of Sediment Texture, Bottom Current Activity, and Benthonic Organisms in the Wilmington Submarine Canyon' is now in-press.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

7.0212, COASTAL AND CONTINENTAL SHELF SEDIMENTATION

J.W. PIERCE, Smithsonian Institution, *Washington, District of Columbia* 20560

To determine the distribution, source, dispersal patterns and transport processes of the sediments of a stable continental shelf and coast in the southern hemisphere.

SUPPORTED BY Smithsonian Institution

7.0213, INTERPRETING THE ORIGIN AND DISTRIBUTION OF COASTAL SEDIMENTS

D.J. STANLEY, Smithsonian Institution, *Washington, District of Columbia* 20560

a. Problems pertaining to distinguishing subtle differences of sands deposited on beaches, dunes, and tidal channels are being examined in the Sippewissett Marsh area, Cape Code, Massachusetts and Sable Island off Nova Scotia using sedimentary petrography, and primary structures. Data is being integrated for interpretation by using statistical methods. Mr. Buttner is processing data with computers. b. The dispersal patterns of sediments in a micro-fjord on the coast of Nova Scotia is also being interpreted using mineralogy, texture, seismic profiles, and analysis of Foraminifera (Dr. F. Medioli).

SUPPORTED BY Smithsonian Institution

7.0214, MODERN VERSUS RELICT SEDIMENT PATTERNS ON CONTINENTAL MARGINS

D.J. STANLEY, Smithsonian Institution, *Washington, District of Columbia* 20560

a. To map and evaluate the distribution of sediments and morphology on the Nova Scotian Shelf and to relate patterns to relict (pre-Holocene) and to modern processes. Problems of Pleistocene ice sheets, fluvial processes, tertiary outcrops, seasonal ice flow over the shelf and recent transgression of the sea must be evaluated. b. Effects of recent eustatic low stands of sea level have affected the morphology of the Bermuda platform. These are being interpreted with high resolution seismic profiles. c. An attempt to investigate sediment transport processes at continental shelf depth is being attempted by observations made in the Man-in-Sea project.

SUPPORTED BY Smithsonian Institution

7.0215, SEDIMENT DISPERSAL PATTERNS IN SUBMARINE CANYONS AND SUBSEA FANS

D.J. STANLEY, Smithsonian Institution, *Washington, District of Columbia* 20560

The purpose of this study is to compare and interpret sedimentation patterns in modern canyons and subsea fans and their probable counterparts in the fossil record. Seismic profiles, bottom current data, photographs, cores and grabs are collected in modern canyons off Nova Scotia, the eastern U. S., the West Coast, and possibly the Caribbean area. Direct observations are to be made in some of these with deep submersibles and via the Man-in-Sea project. Fossil canyon deposits in southern France, the Carpathians, and California are being mapped for a detailed comparison with modern canyon fills.

SUPPORTED BY Smithsonian Institution

7.0216, RADIOISOTOPIC TRACER STUDY TO INVESTIGATE THE MECHANICS OF LITTORAL TRANSPORT AROUND POINT CONCEPTION, CALIFORNIA

D. DWAYNE, U.S. Army, Coastal Engin. Res. Center, *Washington, District of Columbia* 20016

A study to develop techniques to measure sediment movement in the littoral zone is specifically designated for the Point Conception area of the Pacific coast. The basic development program includes a radiation monitoring system capable of deep water monitoring of radioisotopes tagged into sand, analysis of data obtained from measurement of the distribution of the radioisotope tagged sand that has been subjected to the normal effects of waves, tides, and along- shore currents; methods for tagging sand without altering its hydraulic properties and hazard evaluations of the entire transport measuring system. The system is adaptable to sediment transport in both fresh and salt water to depths of 175 fathoms.

The isotope used for sand tagging is 133Xe, thus providing no significant radiation hazard and no alteration of the hydraulic properties of sand indigenous to the test area.

The radiation detection system utilizes scintillation type detectors. Data collection is obtained on punched tape and digital readout from a 400-channel analyzer. Data may be simultaneously coordinated with depth, salinity, and temperature during the monitoring operation.

Cooperative program of federal and state agencies, including: U. S. Army, Corps of Engineers; U. S. Navy, Pacific Missile Range; U. S. Air Force, First Strategic Aerospace Division, SAC; National Aeronautics and Space Administration; U. S. AEC, Oak Ridge National Laboratory; State of California, Department of Water Resources.

SUPPORTED BY U.S. Atomic Energy Commission

7.0217, MECHANICS OF SAND MOVEMENT BY WAVES

T. SAVILLE, U.S. Army, Coastal Engin. Res. Center, *Washington, District of Columbia* 20016

Investigations will be made of the mechanics of sand movement by waves by studying experimental models in a laboratory, by making field measurements and observations, and by analytic theoretical work. Laboratory tests will involve the basic mechanics of sand grain movement under wave action, studying individual grain stresses and movement; data will be obtained in both the field and laboratory on the quantitative movement of sand by waves for different shore configurations, and attempts will be made to relate these to incident wave and current conditions; field measurements will be made of the basic mechanics of sediment transport, particularly by the use of labeled sand grains which can be followed and identified over some distance of movement; the effect of various types of structures on sediment movement will also be examined.

SUPPORTED BY U.S. Dept. of Defense - Army

7.0218, UTILIZATION OF RADIOACTIVE TRACERS IN BEACH STUDIES

G.M. WATTS, U.S. Army, Coastal Engin. Res. Center, *Washington, District of Columbia* 20016

The feasibility of utilizing radioactive and fluorescent tracers in beach studies is being followed and investigated. Preliminary tests familiarizing staff personnel with such techniques are carried out. Study is made to utilize and alter laboratory techniques for field application.

SUPPORTED BY U.S. Dept. of Defense - Army

7.0219, COASTAL PROCESSES - SOUTH TEXAS

H.L. BERRYHILL, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

A topical study of coastline sediments of Padre Island and Laguna Madre to understand the processes involved in transport and deposition of large volumes of sediment along a coastline, the formation and migration of a barrier island, the rate of deposition and geochemistry of sediments in the adjacent lagoon, and the influence of source, sedimentary components and hydrography on the distribution and diagenesis of selected trace elements.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0220, SEDIMENT MOVEMENT AND BOTTOM CONDITIONS IN THE DELAWARE ESTUARY MOUTH AREA

E. BRADLEY, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

The main objectives of this project are to study the local movements of sand waves or ripples and to study bottom sediment transports generally. These will be correlated with tidal currents and quality of water changes. If feasible the effects of catastrophic events, such as floods, hurricanes, or prolonged strong winds, as well as the effects of biological activity on bottom sedimentation will be studied also.

Direct continuous observations of sediment movement utilizing underwater television equipment will be made at several locations. At one or more favorable sites, a screen will be fixed in the bottom and the progress of sand saves moving with tidal currents will be followed with the television camera using video tape equipment where practical. Bottom sediment sampling and quality-of-water measurements will be made periodically during the visual observations.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0221, DISTRIBUTION OF ELEMENTS IN FLUVIAL AND BRACKISH ENVIRONMENTS

V.C. KENNEDY, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

To determine the distribution of major and minor elements in solution, adsorbed, or in solid form in streams, to study the variation in mineralogy and exchange capacity of stream sediments, and their importance in transporting various elements, to investigate methods, such as fluorescent tracers, for following sediment movement into the marine environment and to determine changes in adsorbed ions as sediment moves into the ocean.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7. MARINE GEOLOGY

7.0222, SUBAERIAL AND SUBAQUEOUS FLOW OF SLURRIES

P.D. SNAVELY, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

This study is determining the mechanical behavior of slurries and processes of slurry flow, in laboratory and field, to elucidate the control such processes exercise on the transportation and deposition of heavy minerals, and particularly heavy metals, in the marine environment. This work is being conducted by Stanford University under research contract.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0223, UNIVERSITY OF SOUTHERN CALIFORNIA CONTRACT - CHANNEL ISLANDS AND BASINS SOUTHERN CALIFORNIA CONTINENTAL MARGIN

J.G. VEDDER, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

Objectives of this study include: (1) Detailed identification of mineral components in sediments at the mouths of all active streams that flow into the Continental Borderland; (2) sampling selected representative major drainage systems and their offshore extensions; and (3) to obtain subbottom profiles of the shelf off the Point Conception-Gaviota region to provide information on relative ages of shelf surfaces and sediment thicknesses. This study is being performed in coordination with the University of Southern California under a joint research contract.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0224, TRANSVERSAL DRIFTS IN BOTTOM PROFILE

R.G. DEAN, Univ. of Florida, School of Engineering, *Gainesville, Florida* 32601

Physical relationships between changes in the transversal profile due to sediment transport and the physical mechanisms causing such transport are sought under field conditions in the surf zone of the ocean. Pertinent parameters to be measured are the quantity of sand transport, waves (height and direction), water particle velocities, wind, tide, bathymetry, and sediment characteristics. All instrumentation and experimental facilities have been completed on the previous project for which this renewal proposal is being written.

The method of approach is to measure the time histories of the pertinent parameters over half a tidal cycle, i.e., four to six hours. Since we are measuring over a relatively short time interval a stationary process can be assumed and the techniques of spectral analysis will be employed to correlate the various parameters. This correlation allows direct cause and effect relationships to be obtained. In this manner, insight into the sediment transport phenomenon and basic processes occurring in the littoral zone of the ocean can be found.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

7.0225, AN INVESTIGATION OF THE MASS PHYSICAL PROPERTIES OF CARBONATE MUD SEDIMENTS

J. MORELOCK, Florida Inst. of Technology, School of Engineering, *Melbourne, Florida* 32902

The prime objective of this study is to investigate the mass physical properties of (carbonate) mud sediments. The samples for this study will be collected during a field period of two weeks. Undisturbed samples of carbonate mud will be taken from the western side of Andros Bank in the Bahamas and from the bay area west of the Florida Keys. The Department of Oceanography at Texas A & M University will supply additional cores from Campeche Bank, Mexico. These are all sites of carbonate mud deposition.

Approximately six months will be devoted to the measurement of the physical properties of these sediments. The properties which will be investigated include grain-size analysis, water content, bulk density, void ratio and porosity, specific gravity of solids, shear strength, and consolidation characteristics.

The samples will be analyzed for sediment size distribution, organic content, specific gravity of solids, void ratio, porosity, bulk density, vane shear strength, direct shear strength, and consolidation characteristics. C-14 dates will also be determined.

SUPPORTED BY U.S. National Science Foundation

7.0226, DEEP-SEA SEDIMENTS AND VOLCANIC ROCKS OF MID-OCEAN RIDGES

E. BONATTI, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124 (NONR)

Objective: Navy needs for deep salvage and other operations require knowledge of sediment and rock structures of mid-ocean ridges. These structures and the compositions of the corresponding rocks are affected by the tectonic (structural) development of the ridges. This research will provide knowledge about the structures and compositions of sediment layers on or near the ridges, and on the composition and origin of volcanic rocks on ridges and seamounts.

Approach: Seismic cores and volcanic rock dredge samples will be obtained from selected sites over the Mid-Atlantic Ridge and East Pacific Rise. These samples will be analyzed in the laboratory for chemical composition, for mineralogical and altered mineralogical constituents, and for trace elements in the rocks and overlying water samples. The origins of these materials and their relation to the development to the ridges will be determined; this will provide knowledge on the origin and structural development of ocean ridges.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0227, THE GEOCHEMISTRY, MINERALOGY AND ORIGIN OF PELAGIC SEDIMENTS IN AREAS OF HIGH HEAT FLOW AND FRACTURE ZONES

K. BOSTROM, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

It is proposed to study the effect of high heat flow on the geochemistry, mineralogy and origin of pelagic sediments. Sediment samples from a few selected crossings of fracture zones and high heat flow areas on rises in the Pacific, Indian and Atlantic Oceans will be studied. A geological and geophysical survey of the Easter Island fracture zone, parts of the East Pacific Rise and the Calapagos Rise, that are situated between these fracture zones will be made.

The investigations are expected to clarify: (1) the relations between heat flow and chemical composition of pelagic sediments on rises of various ages, (2) to what extent fracture zones are centers for mineralizing processes, (3) the rate of sedimentation of the sediments and their various constituents, (4) the rate at which various constituents are leached out of sediments during diagenesis and (5) whether leaching of deeply buried sediments may explain the origin of the abnormal crustal sediments, whether the sediments are too thin to account for this hypothesis, or whether the introduction of material from the lower crust and upper mantle must be invoked as an explanation of these sediments.

SUPPORTED BY U.S. National Science Foundation

7.0228, EFFECTS OF DEEP SEA SEDIMENTS ON SUDDEN IMPACT, AS FROM DISASTER VEHICLES

H. FROHLICH, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124 (NONR)

Objective: Navy needs for extricating disaster vehicles buried in deep-sea sediments requires knowledge of the physical properties of such sediments and their response to sudden impact. This research aims at developing such knowledge through laboratory measurements, theoretical analyses, and in situ measurements at sea of the penetration of different shaped free-falling probes into sediments.

Approach: Laboratory measurements will be made on the penetration of various shaped blunt probes, dropped from different heights into barrels filled with compacted ocean sediments. Field tests will be made in Florida lakes of free-falling probes to determine transient and terminal drag coefficients in the sediments. A theory of surface friction will be developed on the basis of the laboratory and field observations, which should be useful in the design of a deep-sea sediment shear testing device. This device will provide in situ measurements that should indicate rates of penetration of free-falling probes into sediments. Sediment cores will be obtained to determine shear strenghts at the test sites.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0229, OCEANOGRAPHY, PLEISTOCENE GEOLOGY AND SEDIMENTS OF LITTLE BAHAMA BANK

A.C. NEUMANN, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

The proposed research includes continuation of the studies on biological erosion of the coasts and Pleistocene geology of the islands as subsidiary aims, the main emphasis being given to a study of the physical energy of carbonate environments. A wave, current, and tide recording tower has been constructed in the Bight of Abaco which is part of the study area. It is proposed to determine the concentration and size distribution of suspended sediment during normal and storm conditions and to relate these data to concurrently obtained wave and current data, to study the effect of oscillatory bottom currents on the natural baffle produced by turtle grass, and to compare the oscillatory bottom currents computed from surface wave characteristics to those measured directly by a Doppler current meter. By means of an energy frequency spectrum, an attempt will be made to summarize the nature and intensity of the physical energy at the bottom over seasonal intervals and to show the relative increment due to single storms.

SUPPORTED BY U.S. National Science Foundation

7.0230, ROLE OF WIND-BORNE CONTINENTAL DUST IN OCEAN SEDIMENTATION PROCESSES

J.M. PROSPERO, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124 (NONR)

Objective: Navy operations require knowledge of the distributions, sources and rates of deposition of sediment in the oceans. The aim of this research is to determine the significance of airborne material of continental origin to various oceanic processes.

Approach: Airborne material is being collected on Barbados following a trans-Atlantic trajectory from Africa. Other dust and ocean particle is being collected from research vessels in the Caribbean and Gulf of Mexico. The material is being analyzed to determine mineralogical and minor -- and trace -- element contents as signatures of source regions. In sea water, the masses and size distributions of suspended matter are being determined and related to the composition of the sea water and underlying sediments.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0231, A SEDIMENTOLOGIC STUDY OF MOBILE BAY AND PERDIDO BAY

H.G. GOODELL, Florida State University, Graduate School, *Tallahassee, Florida* 32306

This is an environmental study of Perdido and Mobile Bay estuaries in Mobile, Alabama, of the distribution of sediments and the three dimensional sedimentary stratigraphy of the deposits in this study in order to write the recent marine geological history of both areas and to predict future sedimentation rates based on past histories.

SUPPORTED BY Alabama State Government

7.0232, GEOMICROBIOLOGICAL WEATHERING PHENOMENA OFF ANVERS ISLAND

D.A. WARNKE, Florida State University, Graduate School, *Tallahassee, Florida* 32306

This award will permit completion of laboratory analysis of materials collected on Anvers Island, Antarctica, during two previous field seasons. The work includes differentiation and identification of bacterial populations, use of percolation columns for data on bio- weathering of different types of rocks, determination of particulate carbon from autoclaved Millipore filters and deep-frozen water samples and completion of determination of selected nutrients from interstitial water of sediment cores. Modal analyses of rock specimens are planned to furnish precise petrographic control of microhabitats. These methods are used to determine the participation of bacteria in the process of chemical weathering of different rock types in the various microenvironments observed in the field; and of the methods by which these nutrients are introduced to the near shore environment.

This terminal year of research will be conducted at Florida State University; the work will complement investigations on filamentous fungi and marine yeasts carried out concurrently at the University of Miami.

SUPPORTED BY U.S. National Science Foundation

7.0233, MAGNETIC PROPERTIES OF ANTARCTIC MARINE SEDIMENTS AND ROCKS

N.D. WATKINS, Florida State University, Graduate School, *Tallahassee, Florida* 32306

Florida State University has, under NSF Grant GA-602 and GA-1123, made closely-spaced measurements on the submarine-sediment cores taken in the Antarctic regions where the Earth's magnetic field is very steep. FSU will continue to determine the vertical complement of the magnetic polarity on samples at 10-cm intervals on almost all cores recovered from the Eltanin. Selected specimens will be demagnetized and three components of natural remnant magnetism measured. These data are being and will continue to be coordinated with a number of other research projects at FSU in geological oceanography and geochronology. Research of particular significance being carried out under this project is the correlation of magnetic reversals with extinction and rapid evolution of fossil microfauna from the same cores.

No research on the USNS Eltanin is contemplated at this time.

SUPPORTED BY U.S. National Science Foundation

7.0234, COMPARISON OF ANCIENT AND MODERN COASTAL CLASTIC SEDIMENTARY ENVIRONMENTS

J.D. HOWARD, Univ. of Georgia, Marine Institute, *Sapelo Island, Georgia* 31327

Two classic regions, representing ancient and modern depositional environments, have been chosen as primary study areas in which a joint approach will be undertaken to establish the pertinent features common to both and to evaluate these parameters as environmental indicators. It is proposed to carry out detailed field investigations of the near- shore sedimentary record in the Upper Cretaceous inter-tonguing marine and nonmarine rocks of east-central Utah and the shallow shelf and coastal plain sediments of the Recent and Pleistocene of coastal Georgia. Secondary study areas are the Upper Cretaceous rocks of the Rock Springs Uplift, Wyoming, and the San Juan Basin, New Mexico, and the Recent and Pleistocene deposits of the Texas Gulf Coast.

The three principal objectives in the proposed study will be: (1) To determine physical and organic features in modern coastal clastic sedimentary environments which are likely to be preserved and which are applicable to the interpretation of similar ancient environments. Particular emphasis will be placed on the relationships between ancient trace fossils and their modern counterparts. (2) To investigate the patterns of shallow-marine paleocurrent systems. Although terrestrial paleocurrents are relatively well understood, shallow marine paleocurrent dispersal systems have not received due attention. (3) To determine effects of diagenesis on sedimentary textures and structures in selected Recent, Pleistocene, and Upper Cretaceous coastal clastic environments.

SUPPORTED BY U.S. National Science Foundation

7.0235, THE POTENTIAL SOURCE, TRANSPORT AND DEPOSITIONAL PATTERNS OF CLASTIC SEDIMENTS IN PORTIONS OF COASTAL GEORGIA

J.D. HOWARD, Univ. of Georgia, Marine Institute, *Sapelo Island, Georgia* 31327

The purpose of this study is to examine the qualitative and quantitative aspects of clastic sediments in the Sea Island Section of the Georgia Coast. Two levels of investigation are included. (1) A detailed study of representative beach (Sapelo Island). In this part of the study weekly beach profiles are made at variations of the beach topography. At the time of profiling, sand samples are collected for grain-size and composition analysis and physical data as to sea state are recorded. (2) In the second part of the study, oriented and undisturbed sediment samples are taken, using an N.E.L. Spade Corer. These samples are analyzed for directional properties of sedimentary structures as well as for sediment grain-size and composition. Physical data include current strength and direction, temperature and turbidity are also collected at sampling stations. This portion of the study includes subtidal environments of the shelf and estuaries of the Georgia coast. An Arnham bed-load sampler is being used in an attempt to collect samples of the traction load on the shelf.

SUPPORTED BY U.S. Dept. of Defense - Army

7.0236, ALPINE LIMNOLOGY PROJECT

A.H. WOODCOCK, Univ. of Hawaii, Graduate School, *Honolulu, Hawaii* 96822

Studies of direct significance to marine science do not necessarily end when one moves from the sea to the shore, especially at an island location like Hawaii. The Institute of Geophysics of the University of Hawaii has encouraged and supported work on Lake Waiau, an alpine lake near the 4 km level and close to the summit of the volcano Mauna Kea, Hawaii.

Recent coring of lake bottom deposits has revealed, through carbon dating, sediment ages extending into the late Pleistocene. The lake, resting within the crater of Waiau Cone, is a natural trap for particles falling from the upper part of the atmosphere. Also, numerous coarse ash layers among the sediments tell a story of local ash eruptions. Oceanographers, concerned with understanding deep-sea cores in this region, are finding the lake deposits useful. The study of Lake Waiau and other bodies of perched water on Mauna Kea was started in 1965 and is continuing.

SUPPORTED BY University of Hawaii

7.0237, KINEMATICS OF SEDIMENTS IN BREAKERS

R.L. MILLER, Univ. of Chicago, Graduate School, *Chicago, Illinois* 60637

Laboratory and field studies are being conducted to determine the kinematics of sediment particles in breakers. Turbulence patterns, velocity fields, initial particle motion, accelerating and decelerating settling velocities, and sediments trajectories are being measured for various sizes and densities of beach sediments as related to beach profiles, bottom roughness conditions and breaker forms. Results of these studies will establish more accurate concepts of coastal dynamics.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0238, PALEOSALINITY DETERMINATION BY THE BORON IN ILLITE METHOD

B.F. BOHOR, State Geol. Survey, *Urbana, Illinois*

A direct relationship exists between the amount of boron in natural waters and their total salinity. The clay mineral illite takes up boron and fixes it into its lattice from natural waters in proportion to the amount of boron present in solution. Therefore, the paleosalinity of strata containing illite can be determined by measuring the amount of boron contained in purified illite from that strata.

Shales, clays, limestones, and coals from the Illinois Basin are being analyzed for boron in order to determine their relative paleosalinity and, by analogy, their inferred environments of deposition. The rocks and coal ashes first must be treated to obtain the pure illite clay mineral fraction -- this is done by centrifugation and differential solution. This technique eliminates most of the variables associated with using boron as a measure of paleosalinity. Then the pure illite residue is analyzed for parts per million boron by optical emission spectrography. Faster and more sensitive methods of colorimetric analysis also are being investigated for boron analysis. The project was initiated in 1965.

This technique should find application in stratigraphic problems, such as the paleosalinity of cyclothemic units, and for investigating facies changes involving salinity differences, such as occur laterally in coal swamps.

SUPPORTED BY Illinois State Government

7.0239, KAOLINITE AS RELATED TO ENVIRONMENT OF DEPOSITION

R.E. HUGHES, State Geol. Survey, *Urbana, Illinois*

Poorly crystallized detrital kaolinite occurs in all sedimentary environments. Generally, kaolinite is segregated within a particular facies and predominates in fresh and brackish water deposits. Superposed on the sedimentary distribution of kaolinite is a distribution of authigenic kaolinite which more accurately reflects the geochemical conditions and diagenetic changes at the site of deposition. Processes related to authigenic kaolinite formation are fundamental to the development of chamosite and glauconite.

Coal and related organic-rich environments are known to develop quantities of well-crystallized authigenic kaolinite. Salient variations in Eh, pH, and chemical equilibria are dominant in the development of this variety of kaolinite. Measures of the quantity and character of authigenic kaolinite are being made on coals of the Illinois Basin to reveal the distributional changes in an area where large quantities of information are available which pertain to environmental analysis.

Analytical methods include quantification and crystallinity determination by X-ray diffraction, scanning electron micrographs of textural relations, chemical and mechanical isolation of authigenic kaolinite from low-temperature ash samples, and gross observations of outcrop and core samples.

Considerable research is also being done on associated brackish and marine units to establish the mineralogic variations caused by changes in depositional environment in the Illinois Pennsylvanian sequences.

SUPPORTED BY Illinois State Government

7.0240, ENVIRONMENT OF DEPOSITION OF ARGILLACEOUS SEDIMENTS

N.F. SHIMP, State Geol. Survey, *Urbana, Illinois*

Our studies, just completed, indicate that boron is adsorbed on clays independent of composition so that for a given content of less than 2 microns of clay, marine muds have 30 to 45 ppm more boron than fresh-water muds. In addition, the total boron-clay pair are effective environment differentiators.

Comparison of boron in muds offshore of the Mississippi delta and in streams of its hinterland is currently in progress to evaluate many of the geologic controls that have been proposed for boron and test its efficiency as a discriminator. Cores through the modern delta are available to us, and some 200 mud samples from throughout the Mississippi hinterland, an area of well over a million square miles, have been collected. No one has ever before studied boron over an entire single drainage basin and its equivalent marine muds. The geologic and climatic contrast of the Mississippi's watershed permit an evaluation of the role they play in boron abundance in muds and in the weathering cycle. In addition, we shall determine whether boron can be used to determine shoreline position in a deltaic sequence.

SUPPORTED BY Illinois State Government
Indiana University

7.0241, BIOGENESIS OF CARBONATE SEDIMENTS, BAHAMA ISLANDS

W.W. HAY, Univ. of Illinois, Graduate School, *Urbana, Illinois*

As an outgrowth of studies initiated under NSF grant GP-1991, the Principal Investigator plans to further study the biogenesis of carbonate sediments around Bimini and Turtle Rocks in the Bahama Islands. Field studies will be carried out to sample statistically the faunal communities and to determine what contribution to the sediments has been made by specific organisms. In addition to identification of magascopic forms and animal remains, it is planned to carry out electron microscopic and chemical studies of skeletal materials to further quantify the contribution that specific animals may make to carbonate sediments.

It is already clear that study of skeletal ultraarchitecture by light or electron optical means will permit the identification of almost every kind of grain in a bioclastic deposit within the study area, at least to superfamily and often to a lower taxonomic level. Thus it will be possible to determine the relative contribution of each taxonomic group to a clacarenite deposit and make a quantitative comparison with the living benthos. Chemical studies, which will be extended in this study, have already shown results that are strongly at variance with presently known data, suggesting that certain chemical components of skeletal remains may be controlled by phylectic rather than environmental factors.

The proposed study will also include the tracking of tidal currents by means of radiosonde buoys developed at the University of Illinois. Tidal currents are important with respect to the distribution of bottom communities and must be taken into account if meaningful information on biogenesis of sedimentary deposits is to be obtained.

SUPPORTED BY U.S. National Science Foundation

7.0242, FABRIC OF MARINE MUDS

R.N. GINSBURG, Johns Hopkins University, Graduate School, *Baltimore, Maryland* 21218 (NONR)

A detailed study is being continued on the structure and fabric of marine (and bay) muds to determine the extent to which they are made up of sand-sized aggregates of finer particles and of only finer particles. Initial work will be with shallow water muds, where it has been found that organically bound aggregates (including fecal pellets) are widespread. Subsequent work will be done with deep sea muds. A technique is being developed of sample preparation through freeze drying and fixing with resins that will permit analyses of mud fabrics to be made without the usual damage that occurs when muds dewater as a result of being exposed to the atmosphere.

This type of analyses is different from the conventional grain size analyses of sediments, in which aggregates are destroyed. A proper interpretation of the fabric of muds is needed to assess physical properties of marine sediment.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0243, EXPERIMENTAL AND THEORETICAL RESEARCH ON TURBIDITY CURRENTS

M.P. TULIN, Hydronautics Incorporated, *Laurel, Maryland*

Equipment will be designed and constructed with which laboratory experiments can be conducted on the nature of turbidity currents. Theoretical studies will be made on the growth, steady state flow, and the decay mechanisms of turbidity currents. Experimental verifications of the theoretical work will be made using the laboratory equipment. The role of turbidity currents in sediment erosion and deposition will be investigated.

Knowledge of the methods of sediment transport and of sediment erosion and deposition in the oceans are of importance to the Navy because these affect the structure and composition of the ocean floor and the sub-bottom.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0244, ESTUARINE SEDIMENTATION PROCESSES

M.O. HAYES, Univ. of Massachusetts, Graduate School, *Amherst, Massachusetts* 01003

Detailed studies are being made of sedimentary processes and resultant sediment patterns in various New England estuaries selected as representative of different types of hydrographic conditions, all subject to a large tidal range. Field measurements are being obtained on tidal current velocities, temperature-salinity variations, sediment and sand-wave movement, channel shape and position changes and other environmental factors for the three major estuarine zones: tidal channel and lower sand flats, intertidal sand flats, and salt marsh.

This study should contribute to an improved basis for the prediction of estuarine environmental conditions.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0245, SEDIMENT-FLUID INTERACTIONS

J.B. SOUTHARD, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139

The aim is better understanding of two problems of sediment-fluid interaction: dune mechanics and action of internal waves on sediment beds. The experiments are designed to study the most fundamental aspects without destroying relevance to the oceans. The work will be in a combined flume and wave tank 45 feet long.

Work on bottom sediment movement and dune formation should provide better understanding of changes in bottom topography, perhaps leading to prediction of such changes. Enhanced understanding of fluid-sediment dynamics should aid in design of bottom-mounted structures and in understanding some of the bottom characteristics important to other operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0246, QUANTITATIVE AND QUALITATIVE CHARACTERISTICS OF MATERIALS CONTRIBUTING TO SEDIMENTATION IN LAKE ERIE

J.F. CARR, U.S. Dept. of Interior, Biological Laboratory, *Ann Arbor, Michigan*

Collecting devices are being used to obtain materials as they settle from the water column but before reaching the bottom. Measurements are made of the percentage of the various components (plankton, clay, detritus, etc.) making up the sediments. In addition, measurements are made of sedimentation rate, oxygen demand, percent organic matter, nutrient content, and (hopefully) geographic origin of the material.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

7.0247, LAKE SUPERIOR CORING III

W.R. FARRAND, Univ. of Michigan, Graduate School, *Ann Arbor, Michigan*

The research herein proposed consists of two phases, (a) completion of studies begun in 1961 and 1962, and (b) continuation of the study of Lake Superior bottom sediments by means of a series of cores to be provided by the Carnegie Institution of Washington.

During 1961 and 1963 about 500 miles of continuous seismic profiler traverses were run in southern and western Lake Superior, and eleven cores were obtained by means of a shipboard drilling rig. The sediment study is nearly complete, but less than half of the seismic profiles have been reduced. In order to bring this project to completion, it is proposed to finish the sediment study (carbonate and humus analysis, heavy mineral study, varve stratigraphy), reduce the remaining seismic provises, and to write the final report.

The second phase of this proposal is a sedimentological study of a series of cores, possibly as many as 100, which will be recovered during the 1966 heat flow study program of the Department of Terrestrial Magnetism Carnegie Institution of Washington. These cores will be 4 to 5 meters long and will provide a great increase in our knowledge of the floor of Lake Superior.

SUPPORTED BY U.S. National Science Foundation

7.0248, PRE-DELTA SEDIMENTATION IN THE ST. CLAIR RIVER DELTA AREA

A.L. POPRIK, Wayne State University, Graduate School, *Detroit, Michigan* 48202

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

7.0249, MICROPLANKTON OF THE BEARPAW SHALE OF MONTANA AND NORTH DAKOTA

N.J. NORTON, Hope College, Undergraduate School, *Holland, Michigan* 49423

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

7.0250, SHOALING PROCESSES

J.B. TIFFANY, U.S. Army, Waterways Experiment Sta., *Vicksburg, Mississippi*

7. MARINE GEOLOGY

The scope and objectives of this engineering study are as follows: (a) To determine the basic laws involved in the movement and disposition of muddy sediments; (b) to determine the effects of repetitive scour and deposition on sedimentation; (c) to develop techniques for radioisotope tracing of sediment movement and deposition; (d) to develop an in-place turbidity meter; (e) to determine the effects of stabilization of deposits on shoaling; (f) to determine the effects of flocculation on shoaling; (g) correlation of prototype data to determine the similarity, or lack thereof, of shoaling processes among estuaries or groups of estuaries; (h) classification of sediments which form shoals in estuaries or other tidal waterways improved for navigation; (i) to determine the facts which affect hydraulic and shoaling conditions in navigation slips and tributary channels which are improved for navigation; (j) to standardize sediment and soil sampling techniques in tidal waterways and to determine suitable methods for the packaging and transportation of samples; (k) to develop reliable methods for the predicting tides and currents in tidal waterways. Field investigations and laboratory studies are presently being conducted under the auspices of the Committee on Tidal Hydraulics to accomplish many of the objectives listed above. The lack of adequate space on this form prohibits discussion of each individual investigation under this project.

SUPPORTED BY U.S. Dept. of Defense - Army

7.0251, RADIATION, DOSIMETRY, CORRELATION AND DATING OF CALCAREOUS DEEP-SEA CORES

N.M. JOHNSON, Dartmouth College, Graduate School, *Hanover, New Hampshire* 03755 (AT(30-1)3860)

The sequence and age of various pelagic carbonates will be analysed by modern methods of thermoluminescent dosimetry. Pliocene-to-Recent calcareous core sections will be correlated on the basis of their self- contained radiation dosimetry. The purpose of the study will be to extend the chronology of deep-sea sedimentation beyond the limit of carbon-14 and the isotopic desequilibrium methods.

SUPPORTED BY U.S. Atomic Energy Commission

7.0252, EARLY DIAGENESIS OF CARBONATE SEDIMENTS IN A SUPRATIDAL EVAPORITIC SETTING

H.D. HOLLAND, Princeton University, Graduate School, *Princeton, New Jersey* 08540

A field and laboratory study is proposed, to determine the sedimentary and early diagenetic features of shelf carbonate sediments. The Persian Gulf has been selected for study. Early diagenetic processes affecting carbonate sediments under evaporitic supratidal conditions are to be examined. The role of fluids in the early diagenesis of mineral phases and of the non-carbonate organic fraction of the sediments is central to the study.

The data and processes found to be important will enable the history of ancient carbonates to be more readily understood and may indicate whether or not shelf carbonate sediments are likely petroleum source beds.

SUPPORTED BY U.S. National Science Foundation

7.0253, RECENT SEDIMENTATION BY TIDAL AND LONGSHORE CURRENTS ON A CARBONATE BANK IN LOWER FLORIDA KEYS

V. JINDRICH, State University of New York, Graduate School, *Binghampton, New York* 13901

No Summary has been provided for use of Science Information Exchange.

SUPPORTED BY Society of The Sigma Xi

7.0254, STRATIGRAPHIC RELATIONS BETWEEN A COQUINA FACIES OF THE YORKTOWN FORMATION AND OVERLYING SEDIMENTS AT CHUCKATUCK, VIRGINIA

N.K. COCH, City University of New York, Graduate School, *Flushing - Queens College, New York* 11367

During a geological investigation of southeastern Virginia from 1961 to 1965 a shoreline complex in the uppermost part of the Late Miocene Yorktown Formation was discovered and briefly studied by Coch (1965). This shoreline complex is composed of bars of biofragmental sand with intervening lagoonal muds. The present study is aimed at determining the Late Tertiary changes in sealevel and to try and account for the missing Late Tertiary-early Quaternary sediment record in the area.

SUPPORTED BY Society of The Sigma Xi

7.0255, CORRELATION OF SUBMARINE VOLCANIC ASH BY CATHODO-LUMINESCENCE

J. DONAHUE, City University of New York, Graduate School, *Flushing - Queens College, New York* 11367

Volcanic ash layers in deep sea sediments are extremely valuable in correlation since they represent isochronous markers. Standard techniques for identifying the layers are however, laborious. Cathodo- luminescence offers a means of identifying layers quickly by means of their specific mineralogic composition.

My present work involves using identified mineral standards to determine the luminescent properties of the various mineral species. Preliminary work indicates that minerals have unique luminescent properties.

The second phase of work involves examination of volcanic ash layers to determine their mineralogy. Determinations made up to this point indicate that this method will allow rapid identification of individual ash layers for correlation.

SUPPORTED BY City University of New York

7.0256, QUATERNARY OF THE HUDSON RIVER ESTUARY

W.S. NEWMAN, City University of New York, Graduate School, *Flushing - Queens College, New York* 11367

We are examining the form and sediments of the Hudson River Estuary from Kingston south to the Narrows. Both published and unpublished data find the valley's bedrock thalweg at inconsistently varying elevations: about -200 feet at Kingston, more than -200 feet near Marlboro, at almost -400 feet at Newburgh, more than -700 feet at Storm King, a similar depth at the Tappan Zee Bridge, at about -300 feet opposite Manhattan Island, but only about -200 feet near the Narrows. The bedrock valley form confirms its identity as a fiord. However, the valley cutting age remains uncertain.

The sediment in the valley consists of till, outwash, lacustrine silt, fluvial sand, estuarine organic silt and tidal marsh peat. Paleontological analyses of bore samples adjacent to Iona Island, just south of the Bear Mountain Bridge, suggest the estuary has been in existence for at least 12,000 radiocarbon years. Archeological shell middens at Croton and Montrose Points indicate the estuary achieved salinities of 8 o/oo or more 4-6,000 years B.P., more than twice those presently obtained at these localities. Decrease in salinity is probably due to estuarine clogging by sediments in the sense of Emery (1967).

A marine transgression curve constructed from the Iona Island data implies the locality suffered post-glacial isostatic rebound followed by subsidence during the past few thousand years.

SUPPORTED BY City University of New York

7.0257, LITHOLOGICAL AND MICROPALEONTOLOGICAL INVESTIGATION OF OCEAN SEDIMENT CORES

D.B. ERICSON, Columbia University, Graduate School, *New York, New York* 10027

Scientists at Lamont Geological Observation have reported the discovery of a sedimentary boundary between the Pliocene and the Pleistocene. Because core lengths available could reach this depth only where considerable overburden had been lost through slumping, there is a gap of unknown thickness representing about 200,000 years of deposition. By continued examination of the cores available at Lamont, it is hoped that other cores will be found, in which the younger sections have been thinned by slumping and whose stratigraphy can be correlated to overlap with cores containing the late Pliocene and Pleistocene sections. There will then be available a complete record of Pleistocene climatic events and the means of estimating a complete Pleistocene chronology, as well as a better understanding of the conditions associated with the glaciation of that period.

SUPPORTED BY U.S. National Science Foundation

7.0258, GRANT FOR STUDY OF SEA FLOOR CORES AND PHOTOS

M. EWING, Columbia University, Graduate School, *New York, New York* 10027

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Bear Creek Mining Company

7.0259, ANALYSIS OF PHYSICAL AND CHEMICAL PROPERTIES OF DEEP SEA CORES

D. HORN, Columbia University, Graduate School, *New York, New York* 10027

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Texas Instruments Incorporated

7.0260, MARINE GEOLOGY

G. NEUMANN, New York University, Graduate School, *New York, New York* 10003 (NONR)

The objective of this research is to describe quantitatively the sediment transport mechanism active off the coast of California and to draw from this description general conclusions which are applicable to coastal regions around the world. During the contract year the current regimes in the San Pedro and the Santa Barbara Channels will be studied as they relate to suspended sediment load transportation. In addition work will continue in the Redondo submarine canyon, with emphasis on the bulk properties and strength of sediments in the canyon's head, axis, and fan.

The character of nearshore and oceanic sediments and of the wave and current processes by which they are eroded, transported, and deposited is of considerable importance to operations involving ocean-bottom and nearshore engineering and construction, and search and rescue. This program will contribute significantly to an understanding of nearshore sedimentary processes.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0261, FACTORS EFFECTING RATES OF ORGANIC DEPOSITION AND QUALITY OF WATER

L.C. MARSH, State University of New York, Graduate School, *Oswego, New York* 13126

This is exploratory research concentrating on the swamps at Port Bay, Beaver, and Sterling, all located rather close to Oswego. Both depth and aerial extensions of the swamps and related bogs are needed. It is hoped to identify the sources of bog vegetation and to relate the swamp to the underlying clay deposits. Such deposits appear important to water flow restrictions and subsequent internal chemistry. Extensive sampling will be followed by radiocarbon dating and pollen analysis.

SUPPORTED BY State University of New York

7.0262, COLLECTION, REDUCTION, AND INTERPRETATION OF SEISMOLOGIC AND PHOTOGRAPHIC DATA

M. EWING, Columbia University, Graduate School, *Palisades, New York* 10964

The study of sedimentation processes and distribution of sediments in the ocean basins will be continued, the ultimate purpose being to improve the knowledge of the history of the oceans and of the marine portion of the entire geologic record. Seismic profiles, bottom photographs, nephelometer, and current measurements incorporated with a sediment sampling program can be expected to answer many questions about the ages of the ocean basins, the processes and rates of sediment accumulation, and about past environmental factors such as regional climatic variations and oceanic circulation.

SUPPORTED BY U.S. National Science Foundation

7.0263, RESEARCH IN CORE ANALYSIS

W.M. EWING, Columbia University, Graduate School, *Palisades, New York* 10964

Objective: To determine those environmental factors affecting acoustical uses of the ocean. To make acoustic models of the ocean bottom, conduct in-situ observations and experiments. Upgrade theory with advancing state-of-the-art.

Approach: Analyze bottom cores and measure parameters which determine the acoustic properties of sediments. Laboratory analysis will include such items as shear strengths, bulk properties, carbonate content, grain size analysis and computer runs to provide information on the relationship that exists between these properties. Comparison with cores from other surveys will be made.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0264, MARINE SEDIMENTS

C. FRAY, Columbia University, Graduate School, *Palisades, New York* 10964 (N00014-67-A0108-0004)

This program includes the systematic collection, preliminary description, and cataloging of sediment cores and dredge samples. Data are sent to the Oceanographic Data Center. The core collection will continue to be used in support of other researchers, both inside and outside the laboratory. The shipboard coring program will concentrate on the selective sampling of sediments and structures delineated by the sub-bottom reflection data.

A knowledge of the physical, chemical, and biological properties of ocean-bottom sediments is important to operations which involve the interaction of both acoustic waves and manmade structures with marine sediments. This program will provide (1) information on a number of these properties and the processes and factors which control them, and (2) a stock of cores which are available to and used by other investigators in their research programs.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0265, SEDIMENTS IN BAFFIN BAY AND THE EFFECTS OF AN ARCTIC ENVIRONMENT ON MARINE SEDIMENTATION

G.M. FRIEDMAN, Rensselaer Polytechnic Inst. , Graduate School, *Troy, New York* 12181

OBJECTIVE: The Navy needs environmental data as they affect salvage and recovery, DRV and other operations. Such data are also needed because they affect engineering structures which in the future will probably be installed on the ocean floor. This research is specifically designed to provide a suite of data describing sedimentary properties on the floor of Baffin Bay. Such data will improve our knowledge of the sea floor and of sedimentation processes in the Arctic.

APPROACH: The contractor, jointly with the U. S. Naval Oceanographic Office in 1967 collected data and core samples in Baffin Bay. They are currently analyzing these data and materials to study the source of the sediments, their biological content and the water contained in their pore spaces. The results will be related to the physiographic province, ocean currents and ice-rafting which are thought to control sedimentation in Baffin Bay. The results will be extrapolated to predict sedimentary conditions in other Arctic regions.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0266, DIAGENESIS OF CARBONATE SEDIMENTS

G.M. FRIEDMAN, Rensselaer Polytechnic Inst. , Graduate School, *Troy, New York* 12181

This study is concerned with the geochemistry of interstitial waters in shallow-water carbonate sediments.

Cores have been sampled and waters extracted from carbonate sediments off Bermuda and the Red Sea. Analyses for trace element concentration are underway. Florida Bay and Florida offshore cores will be sampled during the winter months.

SUPPORTED BY Amer. Chemical Society

7.0267, CARBONATE SEDIMENTATION IN THE TONGUE OF THE OCEAN, BAHAMAS

O.H. PILKEY, Duke University, Marine Laboratory, *Beaufort, North Carolina* 28516

This project is to study in detail carbonate sedimentation on the floor of the Tongue of the Ocean. The study will involve a general description and analysis of ten piston cores with particular emphasis on detection of the effects of lowered sea levels and the differentiation of glacial and interglacial sediments. A preliminary study of short cores from the Tongue of the Ocean has indicated that carbonate mineralogy may reflect sea level changes. Other sediment parameters may be likewise affected. The biostratigraphy, paleoecology and the influence of sea floor solution and early diagenesis on carbonate sedimentation in this area will also be studied.

SUPPORTED BY U.S. National Science Foundation

7.0268, A RECONNAISSANCE OF COASTAL EROSION IN NORTH CAROLINA

L.J. LANGFELDER, Univ. of North Carolina, School of Engineering, *Raleigh, North Carolina* 27600

Three different approaches are being used to delineate areas of erosion and accretion along the North Carolina Coast. These are (a) the use of aerial photography, (b) the use of wave refraction techniques, and (c) observations of the present configuration of the beaches.

The aerial photography portion is utilizing measurements from selected control points to the beach on aerial photographs made over the last 30 years. The wave refractions portion is utilizing existing swell data and wave refraction procedures using an existing computer program. The present configuration has been observed during the life of the project by multiple field surveys. The results of the three methods will be compared in the final report.

SUPPORTED BY North Carolina State Government

7.0269, HEAVY MINERAL DISTRIBUTION OF THE WHITE OAK ESTUARY-BOGUE INLET AREA, NORTH CAROLINA

P.A. DANIELS, Bowling Green State University, Graduate School, *Bowling Green, Ohio* 43402

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

7.0270, DEPOSITION RATES BY THE PROTACTINIUM METHOD

W.M. SACKETT, Univ. of Tulsa, Graduate School, *Tulsa, Oklahoma* 74104 (AT(11-1)-1540)

This project will continue to study the behavior of uranium and thorium series nuclides in the ocean and sediments. The distribution of 238U, 230Th, and 231Pa and total unsupported 230Th and 231Pa on cores taken on the crest of the East Pacific Rise will be determined in order to investigate the possibility that 234U and 230Th may be mobilized by sub-surface thermal activity and migrate to the sediment- water interface. The collection and sampling of the cores (aboard the Oceanographer) and the analyses will be performed by the principal investigator. Results show that manganese nodules are being deposited very slowly. 230Th and 231Pa are practically useless in determining rates as the unsupported activity decreases to zero a few mm from the nodule surface. The anomalously low 230Th/231Pa activity ratios (less than the theoretical productive ratio of 10.8) have been substantiated. Fourteen elements were determined by atomic absorption photometry. The concentration of Sr and Co were found to decrease with oceanic depth for both Atlantic and Pacific nodules whereas Fe, Pb, and Ti showed a depth dependence only in Pacific nodules. Uranium-thorium series nuclides are being determined in a suite of continental river and near shore marine sediments. For the samples analyzed to date, the 234U/231Pa activity ratio is, within experimental error, the theoretical supported value of 21.6 for both types of sediments. The 230Th/234U activity ratio is less than one for both river and near shore ocean sediments but has a value of 1.4 for an anaerobic mud in an Oklahoma lake. This study is continuing and should prove useful in understanding the geochemical cycle of uranium-thorium series nuclides.

SUPPORTED BY U.S. Atomic Energy Commission

7.0271, PROPERTIES AND ORIGIN OF SEDIMENTS ON THE CONTINENTAL MARGIN OFF WESTERN U. S.

J.V. BYRNE, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

This research will provide (1) basic data on bathymetry, on ocean- bottom currents, and on the acoustical and physical properties of marine sediments and (2) an improved capability for predicting the interactions of sound energy and man-made objects with the ocean floor. The research is directed toward determining the nature and origin of the continental margin off the western United States, and toward evaluating the various processes by which sediment is eroded, transported, and deposited in this region.

APPROACH. Shipboard programs involving ocean-bottom current measurements, bottom photography, sediment sampling, and continuous sounding will be carried out. Bottom samples will be examined in the laboratory for their texture, mineralogical composition, and faunal content. From these combined laboratory and field data, inferences will be drawn concerning the present and past patterns and mechanism of sediment movement from the shoreline to the deep-sea floor.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0272, ABYSSAL PLAIN SEDIMENTATION AND STRATIGRAPHY OFF OREGON

L.D. KULM, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

It is proposed to carry out research on sedimentation and faunal stratigraphy on Cascadia Abyssal Plain and its associated deep-sea channels. The area of investigation will include the eastern portion of Tufts Abyssal Plain, with primary emphasis on Cascadia Channel. Sedimentary and faunal data from piston cores, detailed bathymetric surveys of specific features, and geophysical data will be used to establish the basic framework of sedimentation on Cascadia and Tufts Abyssal Plains. A better understanding of the processes that are instrumental in the development of certain deep-sea plains should result from this work. The studies of the stratigraphic distribution of planktonic micro-organisms in the deep-sea sediments will provide time lines for correlation of events between cores and information on past climatic conditions. These data will make it possible to examine the complex interrelationships between changing paleoclimatic conditions and sedimentation rates, sedimentary processes, and sediment texture and composition, which are known to have had a profound effect on the development of Cascadia Abyssal Plain. The influence of prominent deep-sea channels on the transportation and dispersal of shallow water terrigenous sediments into regions distant from the continent will be investigated. The turbidity current deposits of Cascadia Channel will be studied in detail for a distance of some 2000 km; an attempt will be made to reconstruct the flow regime of the channels. In addition, deep-sea channel and interchannel deposits will be compared. An attempt will be made to evaluate the relative importance of turbidity-current versus ocean-bottom current deposition in the area under investigation.

SUPPORTED BY U.S. National Science Foundation

7.0273, DEEP-SEA SEDIMENTS - THEIR PROPERTIES AND PROCESSES OF FORMATION

T.H. VANANDEL, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Objective: In support of present and future ocean-bottom engineering, search and rescue and other operations, this research provides (i) basic data on bathymetry, on ocean-bottom currents, and on the acoustical and physical properties of marine sediments, and (ii) an improved capability for predicting the interactions of sound energy and man-made objects with the ocean floor. The research is directed toward determining the three dimensional nature of the mechanisms and products of sedimentation in the Panama Basin. This sedimentation regime will then be related to the geologic and oceanographic settings of the basin.

Approach: A shipboard reconnaissance survey of the Panama Basin will be undertaken this year utilizing echo sounders, a seismic reflection profiler, bottom sediment samplers and current meters. The compositional and physical properties of the sediment samples will be analyzed in the laboratory. The preliminary knowledge of the distribution, nature and source of the sediments gained from these initial field and laboratory studies will be used to define the proper areas and most worthwhile approaches for making more detailed field examinations during the next three or four years.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0274, STRATIGRAPHY OF RECENT INTERTIDAL SEDIMENTMENTARY DEPOSITS OF THE SHEEPSHEAD MUDFLAT, NEW JERSEY

E.R. FORCE, Lehigh University, Graduate School, *Bethlehem, Pennsylvania* 18015

No Summary has been provided for use of Science Information Exchange.

SUPPORTED BY Society of The Sigma Xi

7.0275, DELAWARE ESTUARY SEDIMENTATION STUDY

D.W. MOODY, U.S. Dept. of Interior, Geological Survey, *Philadelphia, Pennsylvania*

Sediment transport processes in the Delaware estuary are being studied to determine the rate of shoal development. Measured sediment loads delivered to the Delaware estuary by Coastal Plain streams are much less than the annual estimated volume of estuarine sedimentation. Therefore, other sources of sediment must be identified to balance the sediment budget.

Salinity, sediment concentration, turbulence, and many other parameters are known to affect the rate of sediment flocculation. However, little is known about the quantitative effects of the environment upon sedimentation rates. Through field and laboratory experiments the most significant parameters will be identified; these parameters will then be related to rates of sedimentation measured in the field. Results of this study will be used to estimate changes in the present shoaling pattern due to man-made modifications of water quality and the physical geometry of the estuary.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0276, RELATION OF SEDIMENT STRUCTURES AND FLOW DIRECTIONS OF COASTAL CURRENTS

G.D. KLEIN, Univ. of Pennsylvania, Graduate School, *Philadelphia, Pennsylvania* 19104

The principal objectives of this research are to map the orientation of directional current structures in coastal sediments, relate their orientation to the flow directions of depositional currents, and determine the applicability of the flow regime concept to coastal current systems. The work will complete research recently carried out under NSF grant GA-407. The study is designed to strengthen the interpretive basis of paleocurrent analysis, which has been developed largely from the mapping of directional current structures of ancient sedimentary rocks, largely of fluvial origin. Very little substantiating data are available in which the orientation of directional current structures of recent sediments are compared to the direction of flow of modern currents that formed them.

Concurrently with the field program it is planned to conduct a laboratory study of the directional properties as well as the texture and mineralogy of sediments to determine scalar properties of the structures and down-current changes in particle size and mineral composition. All these data will be used to establish a modern coastal sediment dispersal model for comparison to paleocurrent patterns of ancient coastal sediments. Particle size distributions, bedform geometry, and water temperature will be compared to current velocity data to determine the applicability of flow regime hydraulics to coastal sedimentation.

SUPPORTED BY U.S. National Science Foundation

7.0277, THE ORIGIN OF GRAVEL BARS IN THE INTERTIDAL ZONE, PARRSBORO HARBOUR, NOVA SCOTIA, CANADA

M.G. LAUB, Univ. of Pennsylvania, Graduate School, *Philadelphia, Pennsylvania* 19104

No Summary has been provided for use of Science Information Exchange.

SUPPORTED BY Society of The Sigma Xi

7.0278, ELECTRON MICROSCOPE AND ELECTRON DIFFRACTION STUDIES OF GEOLOGICAL SAMPLES

G. SHIMAOKA, Brown University, Graduate School, *Providence, Rhode Island* 02912 (SD-86)

Approach: In collaboration with the U.S. Air Force, several micrometeorite collectors are to be flown on rocket flights. The particles will be analyzed in this laboratory. In collaboration with the Narragansett Marine Laboratory, samples of ocean sediment are being analyzed by electron microscopy.

Progress: Efforts to obtain micrometeorite samples have to date been unsuccessful. Attempts are continuing. Ocean bottom sediment samples have been obtained and are now being analyzed.

SUPPORTED BY U.S. Dept. of Defense - A.R.P.A.

7.0279, CHEMICAL EXCHANGES ACROSS SEDIMENT-WATER INTERFACES

B.W. NELSON, Univ. of South Carolina, Graduate School, *Columbia, South Carolina* 29208

The chemical characteristics of bottom sediments along the salinity gradient of the Rappahannock River estuary, Virginia are being studied with particular reference to the influence of sediments on the chemical quality of the overlying waters. The distribution of gases, phosphate, nitrate, silica, pH, and redox potential are being determined. The exchange of dissolved substances between the sediments and the overlying waters is being measured. The reactions that take place between solids suspended in natural waters and the waters are being examined. Basic information on the activities of certain chemical species in natural aqueous environments is being obtained. The studies are being conducted in natural environments that are essentially free from the effects of pollution so that a suitable understanding of uncontaminated conditions may be available for comparative purposes.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

7.0280, SEDIMENTARY STRUCTURE

A.M. BOUMA, Texas A & M University System, Graduate School, *College Station, Texas* 77843 (NONR)

This research will involve studies of small-scale sedimentary structure. The character of this structure and lateral and vertical variation should reflect differing transport mechanism and depositional environments. Techniques to be used include X-ray radiography, thin sectioning, microscopy, and photography. Radiographic examination will also be used in conjunction with the geotechnical and sound speed measurements in sediment samples to determine (1) whether or not the samples are suitable for these measurements, (2) what distortions result from testing, (3) what relations exist between micro-sedimentary structure and the geotechnical and acoustic properties of the sediments.

7. MARINE GEOLOGY

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0281, SEDIMENTATION

W.R. BRYANT, Texas A & M University System, Graduate School, *College Station, Texas* 77843 (NONR)

This research is aimed at determining the characteristics of marine sediments in the Gulf of Mexico. The relationships between the acoustic and geotechnical properties of these sediments will be studied under closely controlled conditions of termperature, loading, and saturation. Investigations of submarine slope stability and the role which slumping plays in the modification of submarine slopes will be continued. In conjunction with the geophysics program, this research will also involve continuing studies of the regional geology along the eastern and western margins of the Gulf of Mexico.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0282, CORING OF THE VARVED SEDIMENTS IN SAANICH INLET

A.W. FAIRHALL, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

Cores will be retrieved from the varved sediments of Saanich Inlet, Vancouver Island, to the depth of bed rock (150 feet below bottom) for study and dating of the sedimentary sequence.

SUPPORTED BY U.S. National Science Foundation

7.0283, THE FORMATION OF DOLOSTONE AND CHERT IN THE UPPER MIDDLE CAMBRIAN OF THE GREAT BASIN

J.C. KEPPER, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The partial geographic distribution of the distinctive, regionally extensive limestone - dolostone - chert lithostromes in the upper Middle Cambrian of the Great Basin is known. I suggested, in a preliminary study, that much of the dolostone was formed on the sea floor and just below the depositional interface during early diagenesis.

In the present study I hope to establish further petrographic criteria for the time of formation of the different types of dolomite - sea floor, diagenetic, and post-diagenetic and of the associated laminated cherts. Etched and/or stained thin sections and slab are used.

The percentage of insoluble material with respect to rock type and the stratigraphic distribution of such material is under study. Optical and x-ray analysis of a few samples shows kaolinite and quartz to predominate. The synaeresis of the clay is considered important in the cracking of dolostone laminae prior to the formation of the associated intraformational breccias. The role of these clays in the chemical environment and their effect as stratigraphic permeability barriers is to be studied.

Stratigraphic sections have been sampled and measured in western Utah (Marjum Limestone of the Fish Springs Range), eastern Nevada (Highland Peak Formation), and eastern California (Bonanza King Formation). At least 15 sections will have been examined by September 1967.

Hypotheses regarding the physical - chemical conditions which produced these rocks will be developed from this study.

SUPPORTED BY U.S. National Science Foundation

7.0284, RADIOLARIA IN PACIFIC SEDIMENTS

H. LING, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

Through previous studies of the detailed taxonomy and geographic occurrences of Radiolaria in the surface sediments of the eastern subarctic region of the North Pacific significant biographic differentiations have been established. The proposed study will be made to refine and extend the observed pattern of distribution into the central north Pacific.

SUPPORTED BY U.S. National Science Foundation

7.0285, DEEP SEA SEDIMENTS IN THE NORTH PACIFIC FROM STUDIES OF THEIR RADIOLARIAN CONTENT

H.Y. LING, Univ. of Washington, Graduate School, *Seattle, Washington* 98122 (NONR)

Objective: Effective naval operations require a knowledge of the acoustic properties of ocean-bottom sediments. These properties are strongly related to sediment composition and to the processes by which the sediment was deposited. This research, in addition to providing direct information on sediment types and their distribution within the North Pacific Basin, will lead to a better understanding of the sedimentary and oceanographic environments within which these sediments are being and have been deposited.

Approach: Deep-sea sediment cores obtained in the central North Pacific by University of Washington scientists together with samples from sediment cores taken by other research groups will be analyzed for their Radiolarian content. Variations in the number and type of Radiolaria with respect to depth in a core will be related to variations in the textural and compositional characteristics of the sediments and to their geologic age. Based on the observed variations, correlations between cores of clearly defined sedimentary layers will be attempted. The area of study will be extended to include the entire subarctic North Pacific and the distributional pattern of Radiolaria will be related to the oceanographic environment of this region.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0286, STRATIGRAPHY OF UNCONSOLIDATED SEDIMENTS ON THE CONTINENTAL SHELVES OF THE CHUKCHI AND NORTHERN BERING SEAS

D.A. MCMANUS, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The continental shelf in the Chukchi and Bering Seas is of particular geological significance because the sediment records a classical epicontental sea sedimentary environment, including transgressive sequences. The area represents an excellent model for the study of transgressive sedimentary sequences because of its simplicity in sediment thickness, age, and marker horizons. A study of transgressive sedimentary sequences also must draw upon data on the water properties. Data upon the origin, distribution, and interaction of water masses of the Arctic Ocean and contiguous waters are available at the University, and will be augmented during the time of the proposed research by concurrent physical and chemical oceanographic studies in the area.

The proposed investigation has as its objectives: (1) the description of cores of the entire section of unconsolidated sediment on the continental shelves of the Chukchi and Bering Seas; (2) the interpretation of the subbottom profile records of the section between cores on the basis of analysis of the sediment in the cores; (3) the stratigraphic correlation of sedimentary units; and (4) extension of the knowledge of sedimentary environments down through the section from the well-documented modern environment. By realizing these objectives, a greater understanding can be expected of the nature of transgressive seas and their composite processes and of the control these processes have over the dispersal of sediment components and construction of the stratigraphic section.

SUPPORTED BY U.S. National Science Foundation

7.0287, PROPERTIES AND ORIGIN OF SEDIMENTS IN THE NORTHEAST PACIFIC OCEAN

D.A. MCMANUS, Univ. of Washington, Graduate School, *Seattle, Washington* 98122 (NONR)

OBJECTIVE: In support of present and future ocean-bottom engineering, and sub-surface search and rescue operations, this research will provide (1) basic data on the bathymetry, ocean-bottom currents, and the acoustical and physical properties of marine sediments in the Northeast Pacific and (2) an improved capability for predicting the interaction of sound energy and man-made objects with the ocean floor. The research is directed toward determining the nature and origin of the sediments which have been and are being deposited off the continental margin of Washington and Vancouver Island.

APPROACH: Exhaustive analyses of several sediment cores will be made to determine statistically, the variation of the following descriptive parameters both within and between the several cores: grain size distribution, microstructure, mineralogical and biological content, sound velocity, orientation of magnetic particles, and radiocarbon ages. The most significant of these parameters for use in determining the source, age and mode of deposition of these sediments will then be selected. Analyses of these selected parameters in sediment cores obtained subsequently will be used to reconstruct the geologic history of sedimentation off the Washington Coast.

SUPPORTED BY U.S. Dept. of Defense - Navy

7H. TOPOGRAPHY - GEOMORPHOLOGY

(identification and Interpretation of Bottom Surface FeaturesIncluding Reefs, Seamounts, Etc.)

7.0288, CARIBBEAN GEOGRAPHY

J.J. PARSONS, Univ. of California, Graduate School, *Berkeley, California* 94720

Field investigations are being conducted to provide new and accurate scientific data on the environment, coastal topography and morphology, beach and reef features, climate and vegetation of little- known parts of the tropical islands and the lowlands of the Caribbean, Middle America, Northern South America. This program of coordinated studies is designed to fill the need for comprehensive and detailed geographic information on this important area.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0289, LITTORAL ENVIRONMENT OBSERVATION PROGRAM

J.R. TEERINK, Univ. of California, Graduate School, *Davis, California* 95616

Problem: At many beaches in California data to document existing beach conditions is wholly lacking. This cooperative effort will provide a basis for evaluating our coastal erosion problems.

Solution: Initiation of a cooperative program to observe and document littoral forces, beach configuration and changes occurring at state beaches. Repetitive, systematic measurements collected on a twice-a-day basis for a minimum period of three years will provide a statistically significant volume of data. Hopefully, analysis of the data will result in meaningful correlations between the various recorded parameters and lead to a better understanding of the physical characteristics of the California shoreline and the littoral processes occurring along that shoreline.

SUPPORTED BY California State Government
U.S. Dept. of Defense - Army

7.0290, EFFECTS OF HURRICANE BETSY ON SOME BEHAMA CORAL REEFS

W.H. EASTON, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

It is proposed to complete a study of certain coral reefs in the Bahama Islands which have been subjected to forces of hurricane 'Betsy'. Several reefs have already been examined with the support of NSF grant GP-5206, but the area of maximum storm violence is yet to be studied. It is now planned to examine the area of maximum storm severity off Momma Rhoda Cay. No major storms have passed over the specific reefs under study for thirty five years prior to hurricane 'Betsy', and there is thus a unique opportunity to assess the effects of major storms on the growth of large coral colonies and on the kinds and amounts of debris transported across the reefs. It will therefore be possible to make an evaluation of the importance of the occasional severe storm as a factor affecting geological processes, such as sediment transport and deposition.

SUPPORTED BY U.S. National Science Foundation

7.0291, DRAINAGE PATTERN DEVELOPMENT ON TIDAL MARSHES

R.J. LYON, Stanford University, Graduate School, *Palo Alto - Stanford, California* 94305

A study is being made of factors controlling origin of drainage channels in tidal marshes, and of processes by which these complex systems develop. The relationships of drainage pattern types to specific environmental variables are being identified. Multispectral air photography, combined with ground measurements of incident and reflected light, is being used as an additional research technique.

Operations in tidal marshes are handicapped because there is little knowledge of the fundamental mechanisms of these environments which are dominated and characterized by constantly reversing tidal flow. Tidal marshes are common coastal features throughout the world, and it is essential that these areas be understood so that operations can be properly planned, and equipment appropriately designed and utilized.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0292, STUDY OF BEACH NOURISHMENT ALONG THE SOUTHERN CALIFORNIA COAST

J.R. TEERINK, State Dept. of Water Resources, *Sacramento, California*

Problem: Evaluate the full impact of the combined effects of coastal and tributary watershed development on shoreline changes and prepare a long-range plan for timely nourishment of eroding beaches from land and offshore sand sources.

Solution: Develop an effective and economically feasible plan for replenishing the beaches in Southern California in the following manner: 1. Review geological processes contributing to erosion and shoreline changes. 2. Determine need for beach nourishment. 3. Assess the effects of existing and proposed coastal and tributary watershed structures on the natural movement of sand. 4. Develop semiquantitative sediment delivery rates from coastal watersheds under present and anticipated future development. 5. Delineate sources and determine volumes and physical characteristics of suitable material for beach nourishment for inland sand sources. 6. Develop the economics of a comprehensive artificial beach nourishment program that would provide sufficient quantities of beach material of the proper size and weight to prevent erosion of the beaches.

SUPPORTED BY California State Government

7.0293, SEA FLOOR STUDIES - TOPOGRAPHY AND SHAPE OF THE SEA FLOOR

C.J. SHIPEK, U.S. Navy, Undersea Warfare Center, *San Diego, California* 92140

Objective: To determine environmental factors affecting the acoustical uses of the ocean; determine the characteristics of the sea floor that affect propagation of acoustic energy and the stability of bottom structures useful in surface navigation.

Approach: Conduct investigations to determine: (1) the extent and nature and significance of micro-relief of sea floor (2) the genesis of topographic features (3) the topographic control of sedimentation. Systems for quanititatively assessing the roughness of sea floor microtopography in support of acoustic prediction will be utilized both in photogrammetric analysis of existing photographs and reduction of special continuous line optical profiling data which can be taken either from a submersible or a surface vessel.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0294, SEA FLOOR TOPOGRAPHY

H.W. MENARD, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The objectives of this research in marine geology are to determine and study the physiography, nature, structure, and origin of the ocean bottom and of the materials composing it. In these studies use will be made of bathymetric data in conjunction with supplementary information from bottom photographs, cores, dredges, magnetic measurements, and reflection profiling records. In the coming year, emphasis will be placed on investigations into the origin of abyssal hills.

The effectiveness of naval operations which utilize sound propagation is strongly dependent upon the physiography of the ocean bottom and the acoustic properties of the sediments in the areas of operation. The processes which determine the physiography of the sea floor also exert a strong influence on sediment properties including sound reflectivity. The bathymetric information and increased understanding of deep-ocean sedimentary processes which this program is providing should contribute significantly to the operational capabilities of the Navy.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0295, SUBMARINE CANYONS

F.P. SHEPARD, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038 (NONR)

The objective is to understand the processes, past and present, forming or modifying subsurface features at moderate depths, especially submarine canyons. Most of the data is bathymetric, supplemented by bottom cores and other collections and direct observations by divers and deep research vehicles. Much of the coming year will be devoted to a study of coastal erosion and progradation based on a large collection of photographs made over many years. In addition, it is planned to bring much unpublished work to completion.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0296, EVOLUTIONARY DEVELOPMENT OF CUSPATE FORELANDS

J.W. PIERCE, Smithsonian Institution, *Washington, District of Columbia* 20560

To investigate the processes involved in and the natural development of a cuspate foreland and associated continental shelf and coastal plain.

SUPPORTED BY Smithsonian Institution

7.0297, COASTAL MORPHOLOGY

R.J. RUSSELL, Louisiana State University, Coastal Studies Institute, *Baton Rouge, Louisiana* 70803 (NONR-1575(03))

Beaches and coastal areas are being studied in a wide variety of environmental regions throughout the world as a factual basis for formulating fundamental concepts on the physical processes, distribution and interrelations of coastal phenomena. Emphasis is currently placed on the study of alluvial coasts in the tropics and on the dynamics of shore processes. In addition, an investigation is being made of the availability of significant coastal data and systems of handling these data.

Many operations such as personnel survival and rescue, construction, and supply and communication activities, places heavy demands for detailed and accurate information on the coastal zones of the world. At present, while the store of such information is increasing, it still falls far short of the requirements. Data on the nature and characteristics of coastal features obtained, and the theories being developed, provide a basis for more reliable prediction of conditions in deltaic and tidal-flat areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0298, PHYSICAL GEOGRAPHY OF TROPICAL COASTAL LOWLANDS

H.J. VANN, State University of New York, Graduate School, *Buffalo, New York* 14214 (NONR-4501(00))

Field studies are being made of tropical coastal lowlands to determine their physical characteristics, distribution and relationships of landforms, waterways and vegetation, and rates and causes of change. Study areas are selected which exhibit differences in particular properties of the environment, such as tidal range, size and abundance of incoming sediments, rainfall amounts and periodicity, and flow rates of rivers. The studies seek to define and explain the influences such environmental differences have on the formation of features and on coastal processes. 129

These detailed studies of tropical coastal zones provide the Navy with data needed in establishing a more accurate basis for predicting environmental conditions likely to be encountered in poorly known tropical areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0299, SUBMARINE TOPOGRAPHY

B.C. HEEZEN, Columbia University, Graduate School, *Palisades, New York* 10964

The broad objectives of this research in marine geology are to study and determine the physiography, nature, structure, and origin of the ocean bottom and of the materials composing it. In these studies, use will be made of echo sounding data in conjunction with supplementary data from bottom photographs, cores, dredges, bottom current measurements, and reflection profiling records. The physiographic diagram of the southwest Pacific should be completed in the near future.

Many operations are related to the physiography of the ocean bottom and the properties of the sediments in the areas of operation. The processes which determine the physiography of the sea floor also exert a strong influence on sediment properties. The physiographic diagrams, echo soundings, and the increased understanding of sedimentary processes which this program is providing should contribute significantly to the capabilities of the Navy.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0300, REDUCTION AND INTERPRETATION OF PHYSIOGRAPHIC DATA ACQUIRED ABOARD LAMONT RESEARCH VESSELS

B.C. HEEZEN, Columbia University, Graduate School, *Palisades, New York* 10964

The principal aims of the proposed submarine geological research are the delineation of submarine geological features and the explanation of these features and distributions in terms of processes, morphological evolution and history. The starting point of any study of the sea floor is the accumulation and analysis of topographic data. The continuously recorded precision echograms are studied directly for a detailed knowledge of local conditions but for regional studies data must be reduced to charts and profiles. Such profiles are then examined for systematic variations and for unique features and preliminary physiographic province maps are compiled.

The submarine topography program at Lamont has been directed towards: improving the precision and resolution of echo-sounding systems; developing rapid data processing and reduction techniques; reducing the data and plotting them as profiles as well as on charts; developing digital computer methods of topographic analysis; interpreting the morphologic data in conjunction with sediment data obtained through coring, bottom photography and seismic reflection and refraction measurement as well as in conjunction with gravity and magnetic data; the production of physiographic diagrams of oceanic regions; and the general synthesis of the submarine geology of entire oceans.

SUPPORTED BY U.S. National Science Foundation

7.0301, REGIONAL COASTAL CHANGE

H.G. RICHARDS, Acad. of Nat. Sci. of Phila. , *Philadelphia, Pennsylvania* 19103 (NONR(C)00005-67)

Through the study of marine mollusks and other invertebrates of the coastal zones, interpretations are being made of pre-Recent climatic and ecologic conditions related to coastal deposition and erosion. Shorelines and coastal forms are being dated so that a reliable chronology of coastal events may be constructed and correlated with Pleistocene shoreline developments in various regions of the world.

Improved knowledge of the sequence, timing, and regionality of past coastal changes provides a rational framework against which to judge and interpret the magnitude, duration and causes of present coastal changes. Identification of the past regional geographic conditions that accompanied periods of coastal erosion or deposition should assist in improving long-term predictions of environments.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0302, EXPERIMENTAL VERFICATION OF WIDE SWATH OCEAN BOTTOM CONTOURING WITH SPLIT BEAM RECEIVERS

M.A. CHARMIEC, Raytheon Company, *Portsmouth, Rhode Island*

Experiments attempting to verify the concept of using sonar split beam receivers (BDI's and SSI's) for wide swath ocean bottom contouring were carried out with the cooperation of the U.S.S. Hammerhead, SSN- 663, while this attack class submarine transited from Puerto Rico to St. Croix. Outputs from the top and bottom half split beams were recorded and concurrent pictures taken of the SSI display. The recorded outputs were later played back through a BDI receiver and further displayed on a 10' CRT and on a Sanborn Strip Chart recorder. Each sweep of the display represented an ocean bottom contour taken in an athwartship direction. Various depression angles were attempted which resulted in athwartship bottom contours of various lengths and orientations with respect to the ship. A map was prepared which stacked a sequence of consecutive profiles representing a three mile wide swath one mile long starting four miles away from the ship and extending to seven miles. Considerable information was contained in each trace, and trace to trace correlation was evident resulting in patterns which may represent bottom hills and valleys. No actual bottom model of this area is available so the validity of the map cannot be checked.

SUPPORTED BY Raytheon Company

7.0303, SEA USE

C.R. ABBEY, Honeywell Incorporated, *Seattle, Washington*

Project SEA USE is a comprehensive, multi-year scientific and engineering program utilizing Cobb Seamount. Cobb Seamount is 270 miles west of Grays Harbor, Washington, and rises from depths of 9000 feet to within 120 feet of the surface of the Pacific Ocean. Of the many seamounts in the Pacific, Cobb Seamount rises closest to the surface. Because of the location of the pinnacle in the photic zone and its basically undisturbed deep ocean environment, the seamount site is ideally suited for marine science and engineering activities.

The objectives of Project SEA USE are: to characterize the chemical, physical, geological and biological features of the seamount and its environs; to demonstrate that man can occupy, perform meaningful scientific work, and do underwater construction at a seamount far distant from land based support and facilities; and to apply presently available deep-ocean technology in integrated support of a scientific program.

An instrumented mast will be firmly anchored to Cobb Seamount and provide a stable platform for precise measurements of tides, currents, air-sea interactions and weather data.

Project SEA USE commenced in fiscal year 1968 and is anticipated to be a continuing multi-year program.

SUPPORTED BY Washington State Government

8. ENGINEERING AND TECHNOLOGY

8A. AQUACULTURE - FISH GUIDING

(technology of Artificial Culturing of Seafood Organisms, FishLadders, Guiding Over Dams. See Also Chapter 5.)

8.0001, CONSTRUCTION OF A NEW SERIES OF SMALL REPLICATION PONDS AND RESEARCH ON THE FACTORS LIMITING FISH PRODUCTION IN IMPOUNDED WATERS

H.S. SWINGLE, Auburn University, Graduate School, *Auburn, Alabama* 36830

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Rockefeller Foundation

8.0002, SYSTEMS ENGINEERING AND DEVELOPMENT OF COMMERCIALLY VALUABLE MARINE RESOURCES IN THE DELAWARE AREA

F.C. DAIBER, Univ. of Delaware, Graduate School, *Newark, Delaware* 19711

The University of Delaware will conduct a project to develop methods of systems engineering for growing and marketing shellfish. The project will involve the culture and selective breeding of oysters under controlled conditions, including the biology of spawning, larval growth, setting of larvae, growth to harvestable size under economical and disease-free conditions, breeding for early maturity and good market qualities. Environmental control will be a key factor. In addition, the influence of climatic water balance on conditions in the estuary and their effects on shellfish will be investigated, and experiments will be conducted on potential means of opening live shellfish by mechanical, sonic, thermal or electrical methods. A program will be initiated for the training of extension agents to work with industry. Graduate students will participate in all aspects of the project, under the Departments of Biology, Agricultural Engineering, Civil Engineering and Geography, and under the Agriculture Extension Program.

SUPPORTED BY U.S. National Science Foundation

8.0003, THE STATUS AND POTENTIAL OF AQUACULTURE

J.H. RYTHER, Amer. Inst. of Biolog. Sci., *Washington, District of Columbia*

The project was undertaken to provide insight into such problems as: 'Should the Federal government initiate a substantial effort to develop aquaculture in the near future?'; 'What is the potential for aquaculture in the War on Hunger?'; and, 'What is the potential for selected aquaculture to improve U.S. fisheries?'.

A survey of the current status of aquaculture in the world was conducted which included definitive studies of selected examples from various geographical areas. These studies described general biological characteristics; methods of cultivation and yields.

Part 1 of the study identified general principles; range of yields; position of aquaculture in the food economy of a country; projections for expansion; and constraints to development. Part 2 concerned invertebrate and algae culture as practiced in various countries and the last section dealt with the culture of marine flatfish in Great Britian; pelagic marine fishes; brackish water fish; trout and salmon in fresh, brackish, and salt waters; warmwater pond fish; and Soviet fish.

SUPPORTED BY Natl. Council on Marine Res. & Engin. Dev.

8.0004, CULTURE OF POMPANO IN BRACKISH WATER PONDS

W.G. PERRY, Rockefeller Wildlife Refuge, *Grand Chenier, Louisiana* 70643

Pompano, one of Louisiana's valued delicacies was considered for pond culture on Rockefeller Wildlife Refuge. The supply of pompano is limited seasonally and the cost of obtaining them is high. Raising pompano in ponds could result in a year round supply and a new fishery industry for the state.

The objectives of this study are: 1. Determine optimum stocking rates. 2. Determine optimum feeds and feeding rates. 3. Determine possible production per acre, survival, food conversion and susceptibility to diseases. 4. Develop methods of management and harvest to produce maximum yields per acre.

SUPPORTED BY Louisiana State Government

8.0005, CULTURE OF ATLANTIC CROAKER IN BRACKISH WATER PONDS

W.G. PERRY, Rockefeller Wildlife Refuge, *Grand Chenier, Louisiana* 70643

The objectives of this study are as follows: 1. To determine production per acre, food conversion, survival and general desirability as a food fish. 2. To develop methods of management for production of maximum yields in brackish water ponds.

The young croakers were obtained in a natural canal, near the Gulf of Mexico and placed in six 0.1 acre ponds at known stocking rates. The ponds will be harvested in late October. Several ponds will be observed for another year in order to determine effects of winter temperatures and to gain information on second year growth.

SUPPORTED BY Louisiana State Government

8.0006, CULTURE OF BLUE, CHANNEL, AND WHITE CATFISH IN BRACKISH WATER PONDS

W.G. PERRY, Rockefeller Wildlife Refuge, *Grand Chenier, Louisiana* 70643

The rapid increase in catfish farms in Louisiana is a good indication that the demand for this freshwater fish is growing. Several large land owners had approached us asking about the possibilities of their raising catfish in coastal Louisiana. Until recently, we could advise them that the freshwater fish could not be grown in waters with salinities of over 1.5 ppt. This, as expected, cut the available acres down considerably.

Fish were stocked in 0.1 acre ponds to determine growth, survival, food conversion and to determine if the freshwater fish could be grown in brackish waters.

The project was initiated in 1967 and will end in 1969. A preliminary report was given at the 22nd Annual Meeting of the Southeastern Association of Game and Fish Commissioners, October 1968, Baltimore, Maryland.

SUPPORTED BY Louisiana State Government

8.0007, DEVELOPMENT OF TECHNIQUES FOR THE AQUACULTURE OF POMPANO

R.E. HILLMAN, William F. Clapp Laboratories, *Duxbury, Massachusetts* 02323

Pompano fry are collected from the surf in Daytona Beach, Florida and transported to the holding ponds on the grounds of the Florida Marine Research Laboratory of Battelle Memorial Institute in Daytona Beach. Fish are then cultured through the adult stage. It is the purpose of the project for developing the optimum conditions for artifical rearing of pompano and to identify the problems inherent in such a task. The effective salinity, temperature, feeding rate, crowded conditions, etc. on the fish are being studied; in addition, studies of the pathology of fish under these unusual parameters are being carried out, as are methods for laboratory spawning of the pomapno.

SUPPORTED BY Battelle Memorial Institute

8.0008, PURCHASE OF MATERIALS FOR & CONSTRUCTION OF, FLOATS, RACKS, BAGS, AND TRAYS FOR THE SUSPENSION OF VARIOUS TYPES OF CULTCH

W.S. MILLER, State Conservation Department, *Oakdale - Long Island, New York*

Purchase necessary materials and construct floats and/or racks to suspend various types of cultch in bulk or as individually strung shell, plastics, ceramic or other fabricated materials which have proved or may prove to be successful in obtaining oyster set.

This will include the fabrication of wire mesh and/or plastic bags for bulk material and trays to suspend adult oysters as brood stock.

The work involved in this phase is to be begun immediately upon approval and will be completed prior to the initial time of spawning.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
New York State Government

8.0009, THE PURCHASE AND INTRODUCTION OF CULTCH MATERIALS

W.S. MILLER, State Div. of Fish & Game, *Oakdale - Long Island, New York* 11769

Purchase and introduce large quantities of natural shell cultch and experimental materials to rafts and on hard bottom areas of pond at optimum time, as determined by continual biological monitoring of spawning and larval development.

The handling and placement of cultch materials in Oyster Pond will involve the participation of: William S. Miller, Senior Aquatic Biologist, Pieter Van Volkenburgh, Conservation Biologist.

Part 3 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
New York State Government

8.0010, METHODS OF REARING EGGS AND LARVAE TO JUVENILE STAGES

C.R. ARNOLD, U.S. Dept. of Interior, Marine Game Fish Research Lab., *Narragansett, Rhode Island* 02882

This initial phase of a longer-term study to evaluate agricultural potential of selected game fish and associated organisms includes design and construction of a closed circulating sea water system with appropriate components for filtering waste metabolites and controlling bacteria. The system will be designed to allow determinations of water conditions including flow rate, turbidity, oxygen and salinity, for hatching eggs and rearing larvae of marine fishes to the juvenile stage. Optimal conditions will be evaluated on the basis of survival and development of eggs and larvae.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

8.0011, CHARTING OF SUBTIDAL OYSTER BEDS AND EXPERIMENTAL TRANSPLANTING OF SEED OYSTERS FROM POLLUTED SEED OYSTER BEDS

G.R. LUNZ, State Div. of Comm. Fisheries, *Charleston, South Carolina* 29401

The South Carolina oyster industry is based almost entirely on intertidal oysters, yet subtidal beds do exist. Two such beds are known to produce more seed per unit of area than the famous James River, Virginia, seed beds. In the past, attempts to expand the growth of oysters subtidally have not been entirely successful. However, by locating areas with comparable environmental conditions to existing deep water beds, and by transplanting deep water seed to them, an attempt will be made to demonstrate a way to expand the industry.

Exploration for deep water growing sites in the more than 3200 miles of creeks and rivers within the State will begin as soon as the project can be activated. Several hundred bushels of seed oysters from the Wando and the Santee Rivers (existing deep water beds) will be moved to the new locations. Survival, growth, and quality of these transplanted oysters will be studied by regular sampling.

Continuing the program next fiscal year, larger amounts of oysters will be moved to test the possibility of introducing a system of oyster culture not now being practiced.

A two man team, yet to be employed, will conduct the survey. The entire project will be under the supervision of Bears Bluff Laboratories.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
South Carolina State Government

8.0012, OYSTER SEED PROPAGATION STUDY

C.S. SAYCE, State Dept. of Fisheries, *Olympia, Washington*

The objective of this phase is the development of an adequate supply of naturally-caught local Pacific oyster seed for industry. This is needed to replace dwindling supplies of imported oyster seed which have been necessary to maintain the Washington Pacific oyster industry at its present level. Field samples of plankton and water samples will be taken during July, August, and the first half of September to determine concentrations of and distributions of Pacific oyster larvae during their pelagic existence. Plankton observations will include the vertical distribution as well as horizontal distribution of oyster larvae. Time, distribution and intensity of oyster setting will be recorded by seven clutching stations located throughout the bay. Areas which appear to have had the best natural spatfalls in past seasons will be investigated to determine ways of utilizing their potential in producing more oyster seed. A study of antifouling chemicals to prevent settling of barnacles, Bryozoa, and Crepidula larvae on oyster clutch will be made. Field collections and observations will be conducted during July, August, and September while data tabulation and hydrographic observations will continue through winter months. The study will be conducted in Willapa Bay, Pacific County, Washington by the Willapa Shellfish Laboratory staff. Part 2 of 3.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

8.0013, FISH TRANSPORTATION

W.J. EBEL, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

One of the important techniques of fisheries management is the transportation of living fishes, sometimes for long distances. The solution of fish-passage problems in Columbia River Basin may require that anadromous fish be carried around dams or other obstructions, either as downstream migrant young or as adults migrating upstream to spawn. In either case, they are subjected to various hazards which may cause serious mortality, immediate or delayed. The purpose of this investigation will be to develop safe and efficient short- and long-range methods of transporting wild anadromous fish and to improve on contemporary methods of transportation.

Current efforts are concentrated on developing a system to detect magnetically tagged adult salmon and to separate them from untagged fish in a fishway. These tags, which are placed in juvenile migrants, will provide information on the survival of transported fish and their ability to home to natal streams when they return as adults. Subsequent research will be directed to the problems of holding fish in collection facilities prior to transport, transferring fish from holding to transport facilities, and reducing mortalities during transport and release operations. Predation, disease, and physiological effects during the various phases of transportation are receiving special attention.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0014, PROTECTION OF FINGERLING SALMON IN TURBINES

C.W. LONG, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

This project is directed toward the assessment of losses of young salmon during passage through Kaplan turbines and the development of methods to reduce these losses.

The passage of juvenile salmon at dams on the Columbia-Snake river watershed is a problem of attrition. When all low-head dams are completed, some stocks of fish may have to pass as many as 10 projects to reach the sea. Problems of passage will be further compounded in the near future when many more turbines will be installed and fish now enjoying relatively safe passage through the spillways will be forced to use the turbines as their only means of egress to downstream areas.

Equipment and techniques are being used to investigate the causes of loss of fish in prototype facilities at Ice Harbor Dam and elsewhere in the Columbia Basin. Fish protection methods fall into three general categories: (1) Operating turbines to minimize mortality, (2) Eliminating lethal agents in turbines, and (3) Bypassing fish around turbines.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0015, FISH GUIDING

J.R. PUGH, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

Fish-guiding techniques examined by this project have included the use of electrical fields, louvers in combination with electricity, and large panel nets in conjunction with self-cleaning traps. Also studied was the distribution of fish in the natural environment as related to application of fish-guiding devices. Reports of these investigations are in final stages as project nears completion.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0016, FISHWAY RESEARCH (BONNEVILLE LABORATORY)

C.R. WEAVER, U.S. Dept. of Interior, Biological Laboratory, *Seattle, Washington* 98102

These studies are designed to provide information applicable to the improved efficiency of fish facilities at Corps of Engineers projects in the Columbia Basin. The investigations are carried out in the Fisheries-Engineering Research Laboratory at Bonneville Dam. Financing is by the Corps and direction of research is under supervision of the Corps Technical Advisory Committee.

A large laboratory area permits construction of full-scale fish facilities for study of the performance and behavior of adult migrating salmon that can be diverted from an adjoining fishway at the dam. Current and proposed studies include examination of the responses of salmon to various jet velocities, submerged orifice flows, temperature conditions, and barrier facilities. Techniques for T.V. monitoring of fish passage are being explored and developed for use in remote control counting of fish at dams. Special aspects of the behavior of juvenile salmon in turbine intakes are also being examined.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8B. BIOMEDICAL ENGINEERING-LIFE SUPPORT

8.0017, DIVING MEDICINE

L.F. MILLER, U.S. Navy, Bureau of Medicine & Surgery, *Washington, District of Columbia* 20390

Objective: Provide biomedical data in support of manned underwater operations in which personnel are exposed to increased pressures. Equipment now available and under development cannot be used with safety and efficiency at depth. Medical problems are presented by: increased pressures of respired gases, producing abnormal pressures and quantities of gases dissolved in the body; and hazards to personnel presented by the wet, cold, dark environment, and toxic, infectious, or predatory marine life.

Approach: Phase I: Data collection and analysis of factors limiting depth, time, and performance of personnel immersed in water and breathing gas under ambient pressure. Factors to be examined are: physical and physiological characteristics of breathing mixtures; nutrition, metabolism, energy requirements and thermal balance; comparisons of the pharmacological and toxicological actions of chemicals in the altered environment; studies of the interrelation of man, microorganisms, and marine life during prolonged underwater living. Phase II: Definition of the most limiting factor or factors. Phase III: Removal of limitations through modification of the environment or by protecting the individual. Effort is primarily split between the Naval Medical Research Institution, Bethesda, Md, and the Submarine Medical Center, New London, Conn.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0018, SUBMARINE MEDICINE

J.P. POLLARD, U.S. Navy, Bureau of Medicine & Surgery, *Washington, District of Columbia* 20390

Objective: support advanced underwater systems through the application of the results of biomedical research. Present life support systems, while workable, are short of the ideal for health, performance and safety of the crew. Further problems are anticipated with the entry into the fleet of small modules for prolonged habitation. The physiological, microbiological, pharmacological, and human performance standards will indicate the need for all indicate the need for and direction of medical and/or engineering solutions to biomedical problems.

Approach: Achivement of this objective involves the following phases: Simulation of the artificial environment under controlled conditions in the laboratory; study of laboratory animals and later of humans in the controlled environment; observation of the medical or engineering solutions to problems defined; biomedical monitoring of submarine personnel and operations to determine the success of solutions achieved, and to provide early detection of biomedical problems. Effort primarily at the Submarine Medical Center, New London, Conn.

SUPPORTED BY U.S. Dept. of Defense - Navy

8. ENGINEERING AND TECHNOLOGY

8.0019, SWIMMER HIGH DEFINITION SONAR

F.J. ROMANO, U.S. Navy, Ship Systems Command, *Washington, District of Columbia* 20360

Objective: Develop acoustic equipment to enhance a swimmer's underwater vision capability. In turbid waters and during night operations visibility is often limited to several inches and a swimmer is effectively blind if he must depend on his unaided vision. This equipment will sufficiently enhance a swimmer's underwater perceptive ability to facilitate underwater construction, maintenance and repairs, and search of ship hulls for foreign objects.

Approach: The approach through industry and Navy labs is divided into four phases: preliminary design, equipment development, field tests, and reporting. The preliminary design phase will delve into the areas of signal processing, miniaturization, and acoustical beam forming in order to obtain information on state-of-the-art.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0020, ONE ATMOSPHERE DIVERS SUIT

F.J. ROMANO, U.S. Navy, Ship Systems Command, *Washington, District of Columbia* 20360

Objective: Develop a hard, self-contained diving suit that will maintain the diver at atmospheric pressure (14.7 PSIA) within the suit. The suit will be operational to 600 feet (continental shelf) and will be capable of extended working period up to 6 hours. At the end of this 6 hour period the diver can be brought directly to the surface with no decompression required. Using present diving equipment, including both hard hat gear and the various self-contained equipment, working dives below 200 feet impose severe decompression penalties on the diver. As an example, a surface supplied hard hat diver working for 2 hours at 250 feet, is required to spend approximately 11.5 hours additional time in the water for the required decompression to bring him the surface. For the diver using self-contained equipment and saturation diving techniques, this same decompression time could be spent in a dry compression chamber, but the personnel and equipment required to support this type diving is extensive and quite expensive. An atmospheric suit of this type will eliminate the decompression problems and physiological penalties associated with all of the present diving systems. This development effort will advance the state-of the-art in deep diving technology and will greatly extend the Navy's deep diving capabilities. To meet fleet requirements the suit will conform to the U S Navy diving manual, and be compatible with existing support equipment (diving tender, etc.) wherever possible.

Approach: The program will be executed in several phases with the majority of the effort contracted to private industry. The first phase of the program will involve a joint and seal feasibility study. The second phase will involve design, fabrication, and test of a complete arm assembly to 6000 feet. If the results of the first two phases are successful, one contract for the development of the complete suit, tested to 600 feet, will be recommended, since this approach will be the most expedient and economical for the Navy.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0021, ADVANCES HEAT SOURCES AND THERMAL INSULATION MATERIALS FOR SWIMMER HEATING

F.J. ROMANO, U.S. Navy, *Washington, District of Columbia*

Objective. Investigate and develop advanced heat sources and thermal insulation materials for cold water protection of swimmers. Present heating techniques are based on electric battery power sources, and are therefore severely limited by the size and weight of the batteries required. Due to the heat transfer characteristics of present suit materials 1000 watts of supplementary power are required to maintain a swimmer in 29 F water. For a typical 6-hour mission involving a swimmer, 120 pounds of batteries would be required. From the size and weight of the batteries involved it is safe to assume that the swimmer could not handle or swim with such a self-contained package. The present effort will be directed toward investigating and developing new and improved insulating materials, and demonstrating feasibility of advanced heat sources for underwater suit applications.

Approach. Investigation will be conducted to determine state-of- the-art and capabilities of heat sources and thermal insulation materials. Basic heat transfer data will be developed for many materials, since very little data is available for these materials at depth. As a result of the in-house study the materials and heat sources deemed promising will be further investigated and developed through industry based on advanced insulators, tradeoffs will be made between the insulators and heat source requirements. As a part of this basic work, heat requirements for various water depts and temperatures will be established.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0022, DEEP DIVING DECOMPRESSION EQUIPMENT AND TECHNIQUES

F.J. ROMANO, U.S. Navy, Ship Systems Command, *Washington, District of Columbia* 20360

Objective: Develop the equipment and techniques to safely and efficiently decompress divers, who are in either a saturated or unsaturated condition, from depths as great as 1000 feet. Diving tables have been developed from depths of 380 feet when using hard-hat equipment and an 84/16 percent ratio of helium/oxygen breathing gas. Saturation diving schedules to depths of 600 feet are being developd under engineering developement system S46-19, deep submergence man-in- the-sea. The necessity of providing the capability to dive to even greater depths is stated and has been proclaimed by the President's Council on Marine Sciences as part of an effort to make more effective use of the sea: Equipment to deliver the diver to these greater depths, sustain his life, provide him with the capability to communicate, navigate, locate objects and propel him about at these depths are being developed under separate task areas. This task area objective is concerned with safety and efficiently returning him to surface atmospheric conditions upon completion of his job.

Approach: The achievement of this objective involves several distinct areas of work in industry and at Navy labs: development of decompression schedules (depth vs time); development of the pressure complexes and control equipment which will provide the required atmospheres; development of recompression schedules for treatment of decompression sickness; and the development of diver performance evaluators which can be used to determine precise adjustments required in the general schedules to fit different categories of divers physical makeup.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0023, SUBMERGED OPERATIONS COMMUNICATIONS (SUBCOM)

F.J. ROMANO, U.S. Navy, Ship Systems Command, *Washington, District of Columbia* 20360

Objective: To provide the swimmer with reliable, intelligible underwater communication. The equipment will satisfy present underwater communications demands, in particular: diver to diver, vehicle intercom, diver to surface craft or any related communication problem. The equipment must operate to depths of at least 1000 feet thus necessitating use of speech conversion equipment to eliminate effects due to high pressure, helium enriched breathing environments.

Approach: Achievement of the objective through industry and Navy labs involves : (a) Develop basic diver to diver communication requipment to satisfy present requirements, serve as an interim system, and provide a testing platform for future development. (b) Utilize basic unit for development of high power vehicle and submarine mounted units and use in helium speech conversion. (c) Investigate effects on speech waveforms from high pressure and helium enriched breathing gases. Electronic methods will be formulated for frequency dividing and formant shifting of these waveforms to improve intelligibility. (d) Design and build breadboard models of speech unscramblers and speech encoders, apply these breadboards to equipment for testing.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0024, THERMALLY SUSTAINED PRESSURE OSCILLATIONS IN LIQUID HELIUM APPARATUS

R.J. HOWSON, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

The phenomenon of thermally sustained pressure oscillations which frequently occur over liquid helium and other liquified gases is modeled and analyzed. The model is a distributed system with a linear temperature gradient. The interaction between the vapor motion and heat transfer is analyzed to derive an expression for the time history of the pressure oscillations.

Cyclic interpretation of the pressure history results in a relationship between four parameters which control the behavior of the oscillations. The four parameters contain information on amplitude of motion, slenderness ratio of the tube, characteristic lengths of the tube, thermal conductivity, specific heat ratio and viscosity of the gas undergoing the oscillations and boundary layer decay.

The effect of changes within the parameters on the theoretical behavior of the oscillating system shows good agreement with the behavior of oscillations in previous experimental apparatus when similar changes are made.

SUPPORTED BY Massachusetts Institute of Technology

8.0025, THE THERMODYNAMIC PROPERTIES OF NITROGEN-OXYGEN MIXTURES

R.L. STEELE, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

This thesis includes a survey of the literature through 1967 on the methods of determination of the thermodynamic properties of nitrogen-oxygen mixtures in the two-phase, liquid-vapor region. The virial expansion, empirical equations of state, pseudocritical constants, excess functions, latent heats, and graphical methods are considered.

The methods just enumerated are evaluated for their simplicity, feasibility, and accuracy. On the basis of the state of the art and the availability of appropriate data, thermodynamic diagrams are constructed for 1, 5, 10 and 20 atmospheres of pressure in the two phase region. Diagram coordinates are enthalpy-composition and entropy- composition. The diagrams at atmospheric pressure show good correlation with known data, while those at higher pressures are best estimates using excess functions and idealizing assumptions.

SUPPORTED BY Massachusetts Institute of Technology

8.0026, THE PURCHASE AND INTRODUCTION OF BROOD STOCK

W.S. MILLER, State Div. of Fish & Game, *Oakdale - Long Island, New York* 11769

Purchase and introduce substantial numbers of adult oysters on rafts and hard bottom prior to attaining ripeness as a spawning stock. Oysters will be used from a shoal, warm water environment early in the season and from a deep, cold water environment later in the season when the initial group has completed spawning.

This phase will be accomplished in accordance with the timing of natural and/or conditioned spawning of the oyster stocks involved and the conditions present in Oyster Pond.

Personnel Involved in this phase will be: William S. Miller, Senior Aquatic Biologist, Pieter Van Volkenburgh, Conservation Biologist.

Part 2 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
New York State Government

8.0027, LIFE SUPPORT RESEARCH

H.R. SCHREINER, Ocean Systems Incorporated, *Tonawanda, New York* 14150

The objectives of this research are concerned with the extension of human capabilities underwater; they are proprietary to Ocean Systems, Inc.

SUPPORTED BY Ocean Systems Incorporated

8C. CARGO HANDLING

8.0028, SURFACE EFFECT SHIP ECONOMIC OPPORTUNITY

UNKNOWN, Stanford Research Institute, *Menlo Park, California*

PURPOSE: To determine the operational and economic feasibility of future SES commercial operation and its national potential.

DESCRIPTION: This study will examine the economic opportunities that may await commercial surface effect ships providing technological problems are resolved. The first phase, Surface Effect Ship System Formulation and Trade Requirements Survey, will identify and describe future trade areas for potential SES application, and include cargo flow and area environmental data; possible competition; and auxiliary transportation systems within the study time frame. Three categories of operation will be examined; short range such as Great Lakes or coastal operations; medium range such as Canada, Mexico or off-shore islands; and transocean. The second and third phases will be devoted to more detailed studies of one or more specific trade areas in each range category, and cover such factors as trade area characteristics, i.e., cargo origin/destination, inland transportation network, ports, weather conditions, cargo handling, interchange facilities, etc; demand and shipping system analysis of potential Surface Effect Ship cargo flow; Surface Effect Ship Configurations and Operations; revenue and cost estimates; and overall U.S. surface effect ship potential.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

8.0029, COMPETITIVE MERCHANT SHIP PROJECT (BULK) DRY BULK COMMODITY FORECASTS

UNKNOWN, Stanford Research Institute, *Menlo Park, California*

Purpose: To forecast the movement of dry bulk commodities in support of the preparation of a plan for developing advanced dry bulk shipping systems.

Description: A comprehensive and independent forecast of expected ocean borne movements of dry bulk commodities, and an assesment of the national need for a dry bulk fleet will be made. Emphasis will be on an investigation of the economic political and technical factors which are likely to effect the world demand for the commodities under study during the next 25 years.

Methods of defining and assessing the national need for dry bulk carriers will be developed by considering a range of possible national goals and estimating the impact that an American Flag dry bulk fleet would have on these goals.

The results will serve as input to the development of a Strategic Development Plan for producing competitive dry bulk carriers.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

8.0030, TRANSOCEAN TUG-BARGE FEASIBILITY

UNKNOWN, Matson Research Corporation, *San Francisco, California* 94105

PURPOSE: To determine the technical and economic feasibility of utilizing separable cargo and propulsion vehicle units in the international transportation of bulk, break-bulk, and unitized cargoes.

DESCRIPTION: This study will examine closely the opportunities and problems of utilizing tug-barge systems in the open sea, and will compare these systems with other competing shipping modes. The first efforts will be a review of current practice and a parametric evaluation of speed, size, power, cubic capacity, etc. This first effort will include evaluation of devices that would be used to couple the cargo unit (or units) to the towing unit.

As broad system characteristics become available from the first parts of the study, engineering analyses will be undertaken in sufficient detail to establish a reasonable degree of certainty as to technical feasibility and component cost.

Following this will be development of a conceptual design for three shipping systems based on the tug-barge concept - a bulk carrier, a break-bulk carrier, and a unitized cargo carrier, and economic analysis of the opportunities that may exist for the American Merchant Marine in 'tug-barge' shipping systems.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

8.0031, MARINE TRANSPORTATION ANALYSIS MODEL

P.B. MENTZ, U.S. Dept. of Commerce, Maritime Administration, *Washington, District of Columbia* 20235

The Marine Transportation Analysis Model is designed to examine the economic characteristics of various ship systems for a specified trade route. The model has been programmed in Fortran IV and is being run on a Honeywell 200 computer. Marine systems able to be accommodated include those with various cargo handling capabilities such as break- bulk ships, container ships, and barge carrying ships.

The trade route may contain up to 10 domestic and 30 foreign ports with service among any number of feeder loops in conjunction with the main ship route. Cargo flow data is accepted as input to the model in a portpair format. An operational analysis is carried out within the program for each subsystem so as to provide appropriate values for the parameters used in the simplified cost structure.

The results of the routine are in the form of annual net cash flow (after amortization) to the ship operator, and annual Government subsidy cost (construction-and operating-differential). Both are computed for 10 variations of ship sailing frequency; each of these variations considering 5 values of ship speed. The output can be used to measure relative marine transportation system performance.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

8.0032, ANALYSIS OF INLAND CARGO CONSOLIDATION CENTERS

UNKNOWN, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

Purpose: To develop a technique for determining the functions, locations, and sizes of optimum inland consolidation centers in selected cargo generating and/or receiving regions.

Description: A mathematical model and an algorithm were developed and programmed for a computer solution to the problem of determining optimum location of centers for the consolidation of less-than-carload lots of break-bulk general cargo into container loads for export, and for the handling and unloading of import containers for domestic cargo distribution. The model calculates the savings to the shipping community accrued by using consolidation centers and trasnporting cargo over land in full containers, rather than transporting the more costly less-than-carload lots.

Data from the Delaware River Port Authority on exporters and importers in Illinois, Indiana, Ohio, Michigan, and Wisconsin were used to exercise the computerized model. In addition, the data was geographically plotted manually by amount exported per day from all exporting cities in these states to provide guidance for computer runs, and insight into the data not readily attainable from formalized computer techniques.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

8.0033, AN OPTIMUM LOADING SEQUENCE FOR CONTAINERSHIPS

A.E. IOANNIDES, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

A model is developed for the optimum loading sequence of containerized cargo of varying densities and destinations. The loading time and cost are taken as the measures of effectiveness and the loading process has to satisfy certain constraints resulting from trim, list, stability and strength considerations.

Table 3, 4, 5, 6, 7, and 8 show the computer programs used and some sample results.

SUPPORTED BY Massachusetts Institute of Technology

8.0034, OPERATION OF BARGE TRAINS IN A SEAWAY

UNKNOWN, Stevens Institute of Technol, Graduate School, *Hoboken, New Jersey* 07030

PURPOSE: To investigate the relative resistance and controllability performance of a single line pushed barge trains versus pull tow barges, and the magnitude of connecting forces between pushed barges.

DESCRIPTION: This research is an integral part of an overall barge study being conducted both at M.I.T. and Stevens Institute Preliminary resistance and controllability tests have been conducted for the first phase of this project, representing both push and pull barge fleets of one to three barges with towboat in single line formation; the dimensions of the barges being 195 ft. ft. draft and the towboat 112.5 ft.

A preliminary analytical study was carried out which indicated that stern skegs are a necessity for pull tows to achieve controllability. Investigation of variable angle skegs is under way.

In the second phase main emphasis will be on the measurement of barge connecting forces and the effect of changing the barge beam.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

8.0035, THE FEASIBILITY OF REDUCED CARGO GEAR INSTALLATION ONBOARD BREAK-BULK CARGO SHIPS

UNKNOWN, Control Systems Research Inc., *Arlington, Virginia*

Using a representative voyage as a test case, this investigation found it feasible to use mobile, self-powered cranes, aboard break bulk cargo liners to replace at least part of the conventional cargo handling gear generally found onboard.

Ninety-three percent of all cargo drafts were found to be less than 2000 lbs. and 97% of all drafts were less than 3000 lbs. Hence, two or three rubber-tired 12.5 ton (commercial rating) hydraulic cranes could be utilized onboard a typical, Mariner type ship with a resultant reduced capital investment in conventional cargo gear of $155,000 to $290,000 per ship. Annual savings could rang from $13,000 to $28,000, including both capital and operating expenses.

Other fringe benefits result from the clear deck space resulting from elimination of kingposts, which space can be utilized for carrying additional containers on deck; smaller ship service generator capacity; simpler hull construction; and the possibility of using the mobile cranes on the shore or pier, if needed. Such an arrangement also permits changes in cargo operations or future alteration for 'all container' cargo at a smaller loss to the operator in invested cargo gear.

The report PB No. 178-963 is available from the Federal Clearinghouse for Scientific and Technical Information, Springfield, Virginia, 22151.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

8D. COASTAL ENGINEERING

(see Also Sub-chapters E, M, and N of This Chapter.)

8.0036, CRITERIA FOR THE DESIGN OF SMALL CRAFT HARBORS

R.Y. HUDSON, Calif. Inst. of Technology, Graduate School, *Pasadena, California* 91109

The objective of this study is to develop design criteria for small-craft harbors by theoretical and experimental research on: (a) response of small vessels, moored to floating docks and piers, to the action of short-period wind wages and seiches; (b) response characteristics of various harbor shapes and dimensions relative to wave period and wave absorbing characteristics of the perimeter walls to waves entering the harbor; (c) the design of protective works (offshore and inshore breakwaters, overlapping jetties, wave resonators, wave traps, etc.) to reduce wave energy entering the harbor, and develop criteria for selection of harbor-entrance plans for waves at start of storm.

By contract with California Institute of Technology, a report, 'Wave-Induced Oscillations of Small Moored Vessels,' by F. Raichlen was completed. This report is concerned with the response of small vessels moored to fixed docks.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0037, DESIGN OF RUBBLE WAVE-ABSORBER

A.M. KAMEL, Natl. Engineering Sci. Co. , *Pasadena, California* 91105

The theoretical aspects of wave absorbers (natural sand beaches, wave traps, and resonators, and rubble-mound absorbers) were reviewed and the findings related to actual situations. A special theoretical investigation was conducted to determine the feasibility of using rubble mount or other construction materials for absorbing wave energy entering harbors. The scale effects related to wave absorbers were studied and solutions proposed to correct scale effects. Tests will be conducted in future years to develop a more accurate method of measuring the short period wave reflection -- absorption characteristics of rubble mounds. Tests of rubble-mound wave absorbers will also be conducted to determine the ratio of reflected to incident wave heights as a function of structure slope, porosity of cover layer, thickness of cover layer; weight and shape of armor unit, dimensions of waves and depth of water. Studies will be conducted to: (a) investigate the energy transmitted through and over rubble-mound structures to develop design criteria for protection of harbor areas; (b) determine the wave- absorbing characteristics of sand beaches, wave traps, and resonators.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0038, ANALYSIS OF AN ATTEMPT TO CONTROL BEACH EROSION AT SCIENTISTS CLIFFS, MARYLAND

L.P. SCHULTZ, Smithsonian Institution, *Washington, District of Columbia* 20560

Our analysis shows that the height of sand accumulated next to a groin is proportional to the height of the groin; the width of the beach is proportional to the length of the groin out to the non-spill- over height during storms.

SUPPORTED BY Smithsonian Institution

8.0039, COASTAL WORKS EVALUATION FOR CHECKING, IMPROVING AND DEVELOPING DESIGN RELATIONSHIPS AND CONSTRUCTION TECHNIQUE

G.M. WATTS, U.S. Army, Coastal Engin. Res. Center, *Washington, District of Columbia* 20016

Data are obtained and studied on the behavior of shore improvement projects during and after their construction. The data are obtained in cooperation with appropriate field offices insofar as practicable. Protective works studied include beach fills which serve to rehabilitate and/or nourish shore segments, as well as gravity or cantilever type shore structures of both monolithic and rubble construction.

Projects currently being followed also involve sand bypassing at improved inlets, permeable and impermeable groins, jetties and breakwaters, and reconstruction of protective sand dunes. Utilizing the collected data, applicable design relationships, both functional and structural, are evaluated. Study objectives are improvement of existing design relationships and construction techniques, or development of new ones.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0040, METHODS OF BYPASSING SAND PAST INLETS

G.M. WATTS, U.S. Army, Coastal Engin. Res. Center, *Washington, District of Columbia* 20016

Data are collected and compiled at all known places where by works of man, sand is passed across natural or improved inlets of the shoreline. Such works presently include:)a) offshore breakwater and lee sand-trap to be periodically emptied by floating hydraulic dredge plant; (b) fixed pumping plant and pipe line system at jettied inlet to provide continuous bypassing; (c) periodic dredging with floating hydraulic dredge plant in overly-widened channel in a jettied inlet; (d) weir-type jetty and retention basin to be periodically emptied by floating hydraulic dredge plant; and (e) mechanical removal and transport by truck haul from updrift accumulation to downdrift eroded area at a fixed littoral barrier. Quantitative and qualitative data, both physical and economic, are to be compiled and analyzed with the view toward development of relationships which will serve as guide lines or criteria in the design of sand transfer systems.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0041, DEVELOPMENT OF CRITERIA FOR ARTIFICIAL BEACHES

G.M. WATTS, U.S. Army, Coastal Engin. Res. Center, *Washington, District of Columbia* 20016

The study is to develop beach fill design criteria, and to establish a systematic procedure for the investigation of the characteristics of littoral material. Program involves 2 steps: (1) Develop design criteria for beach fill through application of statistical principles to special test data; (2) Reexamination studies of completed artificial fill projects to obtain data for comparative evaluation of developed design criteria. Data which have been derived under the functional study of fill projects are utilized in step 2 procedures of developing the criteria for artificial beaches. Studies through contracts with educational institutions are being carried out regarding the use of statistical principles by repetitive collection of field data at one location. High speed computers are utilized in the analysis of the field data.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0042, RUBBLE-MOUND PROTOTYPE STUDIES

G.M. WATTS, U.S. Army, Coastal Engin. Res. Center, *Washington, District of Columbia* 20016

Prototype rubble-mound structures, including structures with pre- cast armor units, are subjected to programmed surveillance for damage or movement of armor units by wave action in order to correlate such data as are obtained with that previously obtained from hydraulic model and theoretical studies. Armor units at selected positions in the structure are permanently tagged, positioned by survey measurement, and subsequently checked semi-annually, or after each major storm, to determine the degree of movement of the units. Wave gaging instrumentation is installed to provide continuous sampling of incident wave action, and survey measurements of adjacent beach and bottom are also taken periodically. Data are currently being measured at three locations on the Pacific Coast which include a rubble-stone jetty; a jetty with pre-cast quadripod armor units, and a shore-connected breakwater constructed with a rubble-stone stem and monolithic concrete head.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0043, LOCALIZED SCOUR AROUND PILING SUBJECTED TO FIRST-ORDER STOKIAN WAVES

M.R. CARSTENS, Georgia Inst. of Technology, School of Engineering, *Atlanta, Georgia* 30332

Scour around a single cylindrical vertical pile subjected to first-order Stokian waves has been studied experimentally on an oscillatory-flow water tunnel. The water moves over the bed with a period of about 3.5 seconds. From an initial flat-bed condition scour- hole depth as a function of time has been observed as a function of time. Two bed materials were 0.297 mm glass beads and 0.185 mm Ottawa sand. Pile diameters were as follows: 0.375 in., 0.751 in, 0.875 in., 1.244 in., 1.732 in., and 1.99 in. The majority of the runs were performed with a water-motion amplitude large enough to maintain a flat but moving bed during the run. A few runs with smallest pile were made with a water-motion amplitude small enough to maintain a flat immobile bed (except around the pile). Results have been analyzed by mass-transport concepts utilizing transport rate equations for inflow and outflow. Similarity relationships have been sought. Final report for Contract No. DACW72-67-C-0017 (Georgia Institute of Technology) will be issued in November 1968.

SUPPORTED BY U.S. Dept. of Defense - Army

8. ENGINEERING AND TECHNOLOGY

8.0044, WAVE FORCES ON BREAKWATERS

V.T. CHOW, Univ. of Illinois, School of Engineering, *Urbana, Illinois*

Shock pressures created by water waves breaking against vertical barriers are examined. These waves were studied in a laboratory using small-scale oscillatory waves in a flume fitted with a beach slope and test wall. The variation of pressure with both time and position on the wall was measured for several wave profiles with heights ranging from 1.11 inches to 3.29 inches with periods ranging from 1.38 seconds to 1.94 seconds, and two beach slopes, 1/25 and 1/10. The magnitude of the shock pressure was observed for each of the wave conditions tested. From analysis of the data, the shock pressure was found to decrease with both wave height and wave length and to be proportional to the cube root of the wave energy. With the cooperation of U.S. Army Corps of Engineers, the experimental work was conducted at the U.S. Army Waterways Experiment Station.

SUPPORTED BY University of Illinois
U.S. Dept. of Defense - Army

8.0045, STABILITY OF RUBBLE-MOUND BREAKWATERS

R.Y. HUDSON, U.S. Army, Waterways Experiment Sta., *Vicksburg, Mississippi*

The objective of this project is to develop formulas and design criteria from which the action of waves on rubble-mound breakwaters can be determined with sufficient accuracy to provide economical and safe designs of full-scale structures.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0046, HARBOR DESIGN STUDIES

R.Y. HUDSON, U.S. Army, Waterways Experiment Sta., *Vicksburg, Mississippi*

The objective of this project is to determine criteria for designing harbors and harbor structures to obtain optimum wave protection for medium and large-size vessels. This will be accomplished by running tests to determine the optimum arrangement of breakewaters and navigation entrances to harbors to obtain the maximum wave reduction in the harbor, and to determine the effect of wave-front curvature on the amount of distribution of wave energy that enters a harbor through navigation openings of various dimensions and orientation with respect to the direction of wave approach. Additional tests will be run to determine effects of the so-called Mach stem phenomena on the optimum orientation of breakwater and vertical-wall piers; the relationship between the rate of wave attenuation in channels through shallow reef areas, and channel lenght, width, depth, and side slope; the effect of extending fill seaward along entrances of channels, through shallow reef areas, on wave pattern at the entrance of the channel and wave propagation through the channel; the relationship between harbor basin geometry and habor response to wave energy reaching the basin via the entrance channel.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0047, WAVE DAMPING SYSTEMS

H.F. MILLER, Uniroyal Incorporated, *Wayne, New Jersey*

Using corporate funds, Uniroyal, Inc. has been studying wave damping systems over the past five or six years. These portable mechanical devices will attenuate wave height when moored as breakwaters. Models have been constructed and evaluated at the laboratory scale. Prototypes of the more promising systems have been constructed and evaluated in small-scale field trials. New concepts are being tested as the project continues.

SUPPORTED BY Uniroyal Incorporated

8E. GENERAL OCEAN ENGINEERING

8.0048, DEVELOPMENT OF AN ADVANCED MISSILE IMPACT LOCATING SYSTEM FOR THE EASTERN TEST RANGE

C.D. LEEDHAM, General Motors Corporation, *Goleta, California* 93017

Design, fabricate and install an improved, advanced missile water impact locating system for use down range from Cape Kennedy in the Eastern Test Range for evaluation of accuracy of certain ballistic missiles. This system will use underwater acoustics, telemetry and advanced signal processing techniques ashore.

SUPPORTED BY U.S. Dept. of Defense - Air Force

8.0049, DEEP OCEAN TECHNOLOGY

R.J. KNIGHT, North Amer. Rockwell Corp., *Long Beach, California* 90803

The Deep Ocean Technology Program is a long-term series of interrelated experimental hardware development projects whose objectives are to generate, expand, and exploit deep ocean technology to fulfill future military and non-military requirements. This study was undertaken to develop capability in all areas associated with the selection of a site for a manned bottom installation (MBI). In conduct of the study, the methodology associated with site selection was developed. The methodology defined the study approach and the requirements and operational considerations associated with the program objectives. The study was limited to sites on the continental shelf with a selected environment and overt operations. Site characteristics have been identified, categorized (chemical, physical, biological, geological) and tabulated. The parameters which must be measured to define the site characteristics have been established and the associated instrumentation to conduct the measurements have been identified. The instrumentation was limited to state-of-the-art or near term (under development). Technological voids in survey equipment have been noted. Correlation of the data have been provided by the establishment of a generalized site survey sequence.

SUPPORTED BY North American Rockwell Corporation

8.0050, OCEAN ENGINEERING RESEARCH

J. GILHEANY, Catholic University of America, Graduate School, *Washington, District of Columbia* 20017 (N00014-67-A-0377-0003)

Research is underway involving six faculty project directors and 21 graduate students in the areas of (1) Submersible and Ocean Cable Dynamics, (2) Metals and Alloy Marine Corrosion Studies, (3) Vibrational properties of transducers by optical homodyning and optical instrumentation, (4) Transition boiling and flow transients, (5) Wall effects on fluid flow, (6) Physical structure of sea water.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0051, DEEP SUBMERGENCE SYSTEMS

G. SEGE, Westinghouse Electric Corp., *Annapolis, Maryland* 21204

During the past year, research continued in areas of technology for 20,000 foot operating depth for application to advanced manned submersible survey vehicles applicable to OLSOR (object location, small object recovery) systems. Research was concentrated in materials and materials selection for personnel hulls, flotation and vehicle structures; recovery concepts; environmental analysis; emergency buoyancy systems and power conversion for propulsion.

System Analysis - Perform effective system integration for manned vehicle search and recovery missions. Complete the preliminary environmental survey and analysis in order to improve operational effectiveness of survey missions. The report will be updated as additional environmental data becomes available and new areas will be added as the need arises. Subjects of interest are bottom roughness and texture, topography, sediment characteristics, currents, object embedment and breakout and visibility.

SUPPORTED BY Westinghouse Electric Corporation

8.0052, OCEAN ENGINEERING STUDIES

H. BECK, Hudson Laboratories Inc., *Dobbs Ferry, New York* (NONR)

This task provides a unified study of engineering problems (such as feasibility, optimum instrumentation and techniques) encountered in the various programs of the laboratory and the Navy research community. Examples are data processing techniques, data acquisition and transmission systems and displays. It also includes continuing work on development and handling of sound sources and receiver packages; underwater instruments and structures including arrays, cables, corers, explosives, side-looking sonars, etc., and studies of ships and shipboard equipage relating especially to the research needs of the laboratory.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0053, PSYCHOPHYSICAL EFFECTS OF XENON FLASHTUBES

J.T. MONTONYE, Univ. of Rochester, Graduate School, *Rochester, New York* 14627

The Coast Guard is seeking information on the psychophysical characteristics of flashtubes that can be of advantage in aids to navigation. The present research at the University of Rochester, which is being performed by a Coast Guard officer pursuing a Master of Science Degree in Optics, is directed toward an explanation of the physical characteristics of flashtubes that contribute to their conspicuousness above threshold. A special 'Visual Research Stroboscopic Unit' on which pulse repetition rate, flashlength and energy level are variable, has been built for the work. Externally triggered, the unit allows various scintillated flash characteristics.

Ironically, the work will basically use threshold observations to determine the physical characteristics of flashtubes that are responsible for their conspicuousness above threshold. It will essentially duplicate the Blackwell and Moldauer temporal forced-choice retinal locus work of 1958 (Detection Thresholds for Point Sources in the Near Periphery) at a background brightness of 10 to the minus 3 power Foot-Lamberts, but using flashtube rather than incandescent sources. By comparison with the Blackwell results, which showed uniform sensitivity across the central retina for a 10 to the minus 3 power F-L background, and the execution of some additional supra-threshold observations, it is expected that a determination of the relative effects of flashtube temporal, spectral and intensity characteristics on conspicuity will be achieved. A number of practical side-effects are anticipated from the work, some of which may be the following: (1) Distribution of energy for flash lengths probably less than the critical duration that will give optimum conspicuousness. (2) Conspicuousness as a function of supra-threshold level for each of six scintillation characteristics. (3) Measurement of the threshold and/or .2 microlux illumination level equivalent fixed intensity of each scintillation flash characteristic.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

8F. INSTRUMENTATION

(measuring and Monitoring Devices. See Also Chapter 8g Equipment)

8.0054, ACOUSTIC LUNEBERG LENS

W.J. TAULIS, North Amer. Rockwell Corp., *Anaheim, California*

Objective: To develop a water inflatable acoustic lens.

Approach: Design, procure and test a breadboard model at sea.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0055, PRESSURE INSENSITIVE VELOCIMETER

H.T. PATTEN, Bunker Ramo Corporation, *Canoga Park, California*

The pressure insensitive velocimeter is an instrument to measure the speed of sound in water, or other fluid media, and is designed to be exposed directly to ambient pressures at great depths greater than 20,000 ft.) without benefit of a pressure vessel to house the electronics. The instrument uses the classic sing-around mode whereby the output frequency of the instrument is equal to the reciprocal of the transit time between transducer and target. Utilizing pressure insensitive electronic components throughout allows a significant reduction in instrument size and weight and enhances the dimensional stability of the sound path. A precision tunnel diode-hybrid zero crossing detector to reduce electronic time delay errors and improve the input acoustic dynamic range was used. Compensation for changes in path length due to compressability of Invar standoffs was achieved by voiding the rear of the target, allowing simple and highly predictable diaphram action to provide the necessary delta. Instabilities from all causes (electronic and mechanical) is less than plus or minus 1/50,000.

SUPPORTED BY Bunker Ramo Corporation

8.0056, MICROWAVE RADIOMETER DEVELOPMENT

C.V. FALCO, Aerojet General Corporation, *El Monte, California* 91734

TECHNICAL OBJECTIVE: The technical objective of this work unit is to develop new techniques for the measurement of thermal radiation intensity of the earth's surface and atmosphere. The distinguishable features are water, ice, dry land, swampland, dense vegetation, dense clouds, heavy rainfall, etc.

APPROACH: The initial work will be modifying and testing a microwave radiometer operating at 19.35 Gliz which was delivered on a prior GSFC contract. An engineering model radiometer will be used for contract effort while 'in-house' work will be conducted with a breadboard model radiometer. The areas of development will include, but not be limited to antenna control, antenna beamwidth, antenna efficiency, phase shifting techniques, receiver noise figure, receiver bandwith, calibration techniques.

PROGRESS: A breadboard model, an engineering model, and ground support equipment were delivered on Contract NAS 5-9680 with Job Order Number 622-160-44-03-84. The breadboard model is at GSFC for laboratory investigations. The engineering model with control and data recording equipment was installed on the NASA Convair 990 and flight tested for instrument evaluation.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0057, DEEP SUBMERGENCE DISSOLVED OXYGEN TRANSDUCER

M.W. GREENE, Beckman Instruments Inc., *Fullerton, California* 92634

Objective: To develop an instrument capable of in-situ measurement of dissolved oxygen in the ocean at depths down to 3000 meters.

SUPPORTED BY Beckman Instruments Incorporated

8.0058, CTFM SONAR

F.J. HESTER, U.S. Dept. of Interior, Fishery Oceanography Ctr., *La Jolla, California*

Development under a Bureau of Commercial Fisheries contract, this Continuous Transmission Frequency Modulated (CTFM) sonar was designed with a high-resolution frequency analyzer to detect Doppler shifts caused by motion and body flexure of target fish. The sonar scans at a speed fast enough to follow rapidly moving tuna schools which are difficult to follow with conventional pulsed sonar. On completion 2 years ago the CTFM sonar was installed on the small Bureau research vessel, Miss Behavior operated by the BCF La Jolla Laboratory.

It was found that tuna usually travel at 5-6 knots and change course frequently. Whenever their body orientation changes, their sonar echoes fade rapidly. Since there is about a 40 db difference in target strength between the presentation of a broadside aspect and a head or tail aspect on these fish, the spacing and orientation of the individuals in the school make it very difficult to maintain contact at ranges greater than 100 meters. Even these short ranges might work well in seining operations but the speed and rapid course changes necessary to stay with a school are such that often the school can out-maneuver the vessel and contact is lost. The same problem does not apply to contact made with schools of clupeids at the same ranges, perhaps because of their small internal intervals. For such fish the rapid scan rate of the

CTFM sonar made it possible to estimate school size and movement at any instant.

The sonar experiments were concluded at the close of FY 1968 and a final report is in preparation. In summary, it is not expected that the CTFM sonar will be applicable to commercial tuna operations as a tactical tool although it has a place in the sonar array of a fishery research vessel.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0059, OPERATIONAL EVALUATION OF NSRT SYSTEM

J.F. SAUR, U.S. Dept. of Interior, Biological Laboratory, *Palo Alto - Stanford, California*

With increasing use of sea surface temperature information on both for research and synoptic forecasting in weather and fisheries, it is necessary that the quality of the sea temperature observations be improved. A suitable system which eliminates much of the instrumental and personnel errors must be developed and thoroughly tested before a large-scale program can be launched to install the systems on merchant ships, fishing vessels and other ships which report these observations. This program is designed to obtain the necessary test data and experience with such a system.

The general objective is to conduct a thorough field test of NSRT units like the two prototypes obtained from Yellow Springs Instrument Co. to: (a) Determine if such systems manufactured in larger quantities retain the quality and accuracy built into the two prototypes; (b) Establish a measure of the longevity and failure rate from a sample of at least 25 units; (c) Develop and test modifications to the instrument which may be deemed necessary in the course of these tests; (d) Obtain a large sample of reliable data as to what degree the temperature stratification causes temperatures accurately measured in the seawater intakes (near surface) to differ from conventional bucket (surface) temperatures; (d) Determine if the NSRT system would be useful as standard equipment for BCF research and exploratory ships and other oceanographic research vessels.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0060, HOLOGRAPHIC STUDIES OF MARINE ORGANISMS

H.P. SILVERMAN, T R W Incorporated, *Redondo Beach, California* (N00014-67-C-0316)

The investigator proposes to demonstrate that holography, the use of lasers in the photographic recording of three dimensional images, can be used effectively in those biological study problems which require observation of dynamic activity throughout a volume of water without excessive loss of resolution. He suggests specifically, the application of the technique to studies of plankton productivity is situ, including enumeration and identification of organisms; locomotion with time lapses in nanoseconds; feeding; setting, and other activities of organisms in approximately the 0.5 to 3 millimeter range.

One of the major problems in biological oceanography research has been the lack of equipment permitting in situ observations. The so- called deep scattering layer which probably interferes with the transmission of acoustic energy underwater has never been clearly characterized because of this lack. The holograph, if it fulfills its promise, will permit direct observation of the density of the biological components of the water sample, measurement of particle size, and size range, and even identification of the organisms present. On this basis, it will be possible to determine the role of the 'layer' in acoustical, as well as optical, interference. The conditions under which fouling and boring by biological organisms occur will be determined, and a great many other mechanisms by which biological pests operate will be elucidated.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0061, INVESTIGATE METHODOLOGY FOR MEASURING OCEANIC PROPERTIES LEADING TO THE TOTAL ENVIRONMENTAL SURVEY OF A SELECTED OCEAN AREA

F.B. CHMELIK, Lockheed Aircraft Corporation, *San Diego, California* 92101

The initial work on this project pointed up the need for a variety of tools and sensors suitable for a deep submersible to use in measuring oceanic properties. Efforts were then directed toward the conceptual design of an in-situ filter/sampler, a deep submergence radiation detection device and a self-generating tube that could be inserted into the sea floor for obtaining core samples or directly measuring mass physical properties.

SUPPORTED BY Lockheed Aircraft Corporation

8.0062, MARINE RADIOLOGICAL INSTRUMENTATION

T.R. FOLSOM, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (NONR)

The purpose of this task is to develop and improve instrumentation and techniques for the measurement of very small amounts of radioactivity in the oceans, and to apply these measurements to studying oceanic circulation. The work involves special sampling equipment for use aboard 'Ships of Opportunity,' the laboratory analysis of the samples, and the instrumentation development.

This task has direct application to the measurement of the fate of radioactive material from waste disposal and other nuclear events. It is also contributing to our knowledge about mixing processes in the oceans which affect those parameters influencing sound characteristics of the oceans.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0063, COMPUTER PROCESSING OF MICROSCOPE IMAGERY

J.L. HARRIS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

This research is directed toward increasing the state-of-the-art of resolving power in optical microscopy. The approach involves utilizing a prior knowledge as to the maximum size of the object and employs computer processing of digitilized image information. The initial funding for this research was received during FY66. The support is on a continuing basis and therefore no termination date has been set.

SUPPORTED BY Amer. Optical Company

8.0064, BIOLOGICAL INSTRUMENTATION

J.M. SNODGRASS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (NONR)

The investigator advises and assists in bio-instrumentation research with hydrobiologists who require specialized equipment in their studies. Instrumentation for analysis of physiological or behavioral responses of organisms to natural or artificial stimuli will be especially considered. Methods for accurate measurements of environmental factors as they relate to or are perceived by biological organisms are investigated. Some pieces of equipment now in use are being studied in regard to adaptation to solid state sensors and microminiaturization.

Research in biological orientation and hydrobiology yield information of immediate and long range potential value to the Navy. The development of new concepts regarding information theory, biological transducers, environmental navigational clues, etc., represents a far- reaching and much needed change of viewpoint from which many new ideas for analogues may be expected to emerge.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0065, INSTRUMENT DEVELOPMENT

J.M. SNODGRASS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (NONR)

The objective of this task is to develop new techniques and equipment which are reliable and suitable for supporting oceanographic research. During the coming year, emphasis is upon technical guidance for the development and production of satellite navigation receivers and the installation of computers on research ships. Efforts are being made to develop an in situ oxygen meter for use at sea. Consulting services on oceanographic telecommunications are being provided to the Navy and the U. S. Government.

The results from this task provide many instruments or concepts necessary for developing environmental data collection systems. Many of the instruments and techniques initially conceived and/or developed under this task, like the expendable bathythermograph, already have become part of standard usage.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0066, HOLOGRAPHIC INSTRUMENTATION FOR MARINE PLANKTON STUDIES
J.D. STRICKLAND, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

The project is to design and fabricate an underwater laser - camera combination which will enable holograms to be taken of the plankton in about 100 liters of water in such a manner that the animals will be viewed in an undisturbed condition making it possible to document any small-scale patchiness and aggregations of ecological significance. We hope to make a preliminary evaluation of cinematic holography as a tool for studying the behavior (feeding, breeding and swimming, etc.) of zooplankton in a relatively undisturbed state.

SUPPORTED BY U.S. National Science Foundation

8.0067, NEW SEA GRAVITY METER
N. BROWN, Bissett Berman Corporation, *Santa Monica, California* 90404 (N00014-67-C-0430)

A new sea gravity meter has been designed and a prototype is now being constructed. The meter will be tested in the laboratory when completed. The meter consists of a quartz-cantilever beam with an ultra-sensitive capacitance transducer to measure changes in gravity as small as 0.1 mgal. The meter is expected to operate successfully on a stable platform for a large range of vertical ship accelerations, up to and exceeding 100,000 mgal. The cost of the meter is anticipated to be considerably less than U.S. made commercial meters now on the market. Sea tests of the meter are planned within a year if the laboratory performance and cost of construction prove to be satisfactory.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0068, FREQUENCY TIME RESEARCH ENGINEERING
P.P. VIEZBICKE, U.S. Dept. of Commerce, Time & Frequency Div., *Boulder, Colorado* 80302

Technical Objectives: To study the feasibility of worldwide time synchronization by means of multiple frequency VLF transmissions including systems engineering, design, and fabrication of component units.

Approach: Two or more closely spaced VLF frequencies, whose phase relationships are precisely specified and accurately controlled, are broadcast by means of time sharing from NBS Radio Station WWVL. Upon reception, if propagation fluctuation is not too severe, the relative phases of these signals with respect to local time signals permit establishment of time synchronization. Engineering parameters, such as optimum frequencies and necessary transmitter power, need to be determined.

Progress: WWVL power amplifier has been redesigned--eliminating the L-C tank circuit and reducing the number of electron tubes in the PA. The antenna feed system was redesigned and permits matched conditions into the 500 ohm open wire line. The design of the generation and control system to convert WWVL to three frequency operation is progressing. Preliminary design has been completed.

Two third-order servo frequency drift correctors have been built similar in design to one now in use in Section 253.04.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0069, UNDERWATER HOLOGRAPHIC IMAGING
D. GABOR, Columbia Broadcasting System, *Stamford, Connecticut*

Objective: To investigate the holographic imaging technique as an underwater sensor.

Approach: Conduct research, design and develop experimental equipment in support of further refinement of the holographic technique.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0070, BIOTELEMETRY
J.R. OLIVE, Amer. Inst. of Biolog. Sci. , *Washington, District of Columbia* (NONR)

The AIBS has established, and now maintains, the Bio Instrumentation Advisory council, a clearing-house through which biologists avail themselves of advice and assistance from physicists and engineers on appropriate techniques, approaches, and instrumentation for biological research. The Council understands biological requirements for the development of improved equipment and technological advances, and keeps abreast of developments in electronics, electrical engineering, and telemetry as they relate to instrumentation. Support is provided from several sources, including ONR and NASA.

One phase of Oceanic Biology Programs has as an objective, understanding of reception and responses to environmental cues or stimuli by biological organisms. This knowledge applies to Navy operational requirements in such areas as: ship-ordnance navigation and guidance, target detection and discrimination, and survival. Instrumentation and operating techniques are necessary to identify and respond to these environmental cues for improved Naval operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0071, AUTOMATED FLOW SYSTEM CALIBRATION
D.W. BAKER, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

Research and development to utilize small digital computers for the automatic readout of instrumentation, automatic control of fluid flow systems calibration, and calculation of performance data. Immediate application is for aircraft flow systems, with benefits anticipated for NBS flowmeter calibration work.

Evaluate and develop transducers and systems for the measurement and control of flow parameters, with signals suitable for input to computers which will be adapted or used to accomplish the automatic calibrations and automatic data processing.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0072, VISUAL RANGE METERS
C.A. DOUGLAS, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

To provide a stable nucleus of specialists, operating in a technical environment, competent to apply the results of basic research and of lessons of the past and the resources of NBS to current aviation lighting and marking problems; to maintain and utilize a photometric and illuminating engineering laboratory competent to make and interpret the specialized measurements required in the development of aviation lighting equipment and systems; to make the required measurements and studies; to develop improved instrumentation for measuring the atmospheric factors affecting visual range; to provide a better knowledge of the threshold constants of the eye applicable to service conditions; to develop the application of these data to the control of the operation of aircraft landing and taking off in conditions of poor visibility (example: Fog Conditions). This is NBS Mission Component 1.6, Research and Development for another agency.

When we are advised of the needs of the sponsor, tasks are initiated to obtain the required data and recommendations formulated on these data are forwarded. Individual tasks usually require from 3 to 24 man-months. Current tasks are: 1. Development of a back scatter visibility meter suitable for use on aircraft carriers. 2. Development of an improved cable-fault locator. 3. Continuing development of the NBS transmissometer and related components. 4. Improvement of the performance of in-runway lights and of glide-slope indicators. 5. Preparation of specifications for air field lighting equipment. 6. Making of photometric and electrical measurements of air field lighting equipment and evaluating the results of these measurements.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0073, MECHANICAL TESTS AND FORCE CALIBRATIONS

F.C. FALKINBURG, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

The prime objective is to calibrate transfer force measuring devices and systems submitted to NBS by industry, standards laboratories, and other governmental agencies. Subordinate objectives include further development of calibration techniques, adaptation of a digital computer to the calibration process and improvement of accuracies in force measurements. This calibration work is directly related to the Bureau's mission of making accurate calibrations of instruments to serve as reference standards for industry and government. Tests of materials, structures and special devices are made for other government agencies and industry when facilities and personnel are not available elsewhere.

Through the use of deadweight machines, highly precise forces from 5 lbf to 1,000,000 lbf are applied to devices submitted for calibration. The performance of each device is determined from operational and load tests, the data are analyzed and a report prepared for the user. The use of a digital computer permits comprehensive analyses and a standardized format for presenting the results. Special mechanical tests are made with testing machines and test facilities with force capacities up to 12,000,000 lbf.

Report interval -- March 1, 1967 through December 31, 1967. Calibrations of 462 force measuring devices were completed during the above period: 345 for private industry and 117 for governmental agencies. Force measuring devices included dynamometers, load cells, transducers, aircraft weighing kits, proving rings, and Amsler boxes. Mechanical tests were made on 26 items for other governmental agencies. These items included wire rope, sine measuring devices, acrylic compression-creep specimens, shackles, exothermic splices, sheet metal lap joints and padeyes for raising submerged ships.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0074, INTERCOMPARISON OF TOWING TANK AND WATER TUNNEL CALIBRATION OF CURRENT METERS

J.L. FRENCH, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

To determine the effect of water-tunnel test-section size on the performance of small Price and Pygmy current meters, and to determine the effect of turbulence level on the registration of water-current meters. The results of these determinations will provide information helpful in the design of a water tunnel which will replace the existing towing-tank current-meter calibration facility. The calibration of current meters by NBS serves the needs of Federal, State and private agencies in this measurement field.

An apparatus has been assembled which simulates the contraction and working sections of a water tunnel. Price meters will be calibrated in 16 and 20-inch diameter tunnel sections and in the towing tank. Pygmy meters will be calibrated in 8, 16, 20-inch tunnel sections and in the towing tank. Towing-tank and water-tunnel results will be compared. The effect of turbulence on both meter types will be investigated by installation of various approach-channel grids to vary the turbulence level in the working section.

The presently available data on the performance of current meters in the simulated working section of the water tunnel, together with the data obtained in the pitot tube calibration of the working section suggest that a water tunnel facility can be designed which will yield current meter (or other velocity sensing device) calibrations fully equal or superior in quality to those now obtained in the present towing tank.

Repeated calibration of various types of current meters in the 20-inch diameter water tunnel section are continuing and will be compared with calibrations obtained in the towing tank.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0075, STRUCTURE OF TURBULENCE

P.S. KLEBANOFF, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

To apply high-speed digital computing techniques to the measurement of the statistical properties of turbulence and thereby provide significantly new data which will extend our knowledge of turbulent processes. Using these techniques the nearly isotropic turbulence field produced by a grid and the shear turbulence in a boundary layer will be investigated. Special attention will be given to the measurement of higher-order correlations and joint probability density distributions of the velocity fluctuations and the fluctuating velocity gradients. The results obtained will have application to problems in aerodynamics, hydrodynamics, atmospheric turbulence, diffusion and mixing processes, etc. This project continues the NBS work on the development and application of various measurement techniques to the solution of important fluid dynamic problems.

The basic idea in applying high-speed digital computing techniques to the measurement of turbulence is to employ the digital computer together with hot-wire instrumentation to form a measurement system capable of performing the large number of complex operations that a detailed study of the statistical properties of turbulence requires. Hot-wire instrumentation converts the velocity fluctuations into voltage fluctuations which are recorded on multi-channel magnetic tape. The signals are then digitized and fed into a 7090 computer which when appropriately programmed provides a quantitative measure of the various statistical properties of turbulence. Apart from the interpretative analysis, the problems associated with programming, a number of technical aspects have to be investigated. These are appropriate instrumentation for obtaining high quality records, sampling procedures, dititizing procedures, noise and nonlinear behavior of the hot-wire.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0076, BASIC ACOUSTICAL STANDARDS AND MICROPHONE CALIBRATION

W. KOIDAN, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

Technical Objective: (a) Development and improvement of methods for the measurement of sound pressure from infrasonic through low ultrasonic frequencies. Measurement methods at audio frequencies and low sound pressures are fairly well established; however, methods for calibration at infrasonic and ultrasonic frequencies and at high sound pressures are still being explored. (b) Maintenance of reference standard instruments (microphones) for sound pressure measurement. Improvement of the Sound Laboratory facilities for the calibration of microphones. (c) Studies of the properties of standard laboratory microphones relevant to their use in measuring sound pressure. (d) Studies of accoustical environments used in the calibration of microphones. (e) Participation in the work of USASI, IEC and ISO relevant to the calibration of microphones.

Approach: (a) Microphone pressure calibration at infrasonic and ultrasonic frequencies to be performed by carrier-frequency techniques or electrostatic actuator. Free-field calibration at infrasonic frequencies by plane-wave tube or small box. Free-field calibration at ultrasonic frequencies in a small anechoic chamber. High-intensity calibration in a special progressive-wave tube. (b) Perform periodic primary pressure calibrations at audio frequencies in small, closed couplers by reciprocity technique. Perform periodic primary free field calibrations by reciproby reciprocity in anechoic chamber. Microphones thus calibrated serve as reference standards. (c) Measure and calculate theoretically electrical and acoustical parameters and the electromechanical coupling factor of condenser microphones.

Above work relates to calibration and design of improved transducers and hydrophones for underwater acoustic measurement and communications.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0077, PHOTOGRAPHIC STANDARDS

C.S. MCCAMY, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

Methods of measuring the characteristics of photographic systems are developed and interlaboratory comparison programs are arranged to validate procedures before they are standardized. The fundamental concepts, terminology, and notation for measures of optical characteristics are investigated theoretically and proposed for standardization.

The final draft of a USA standard method of measuring the resolving powers of photographic films, plates, and papers has been approved and the illustrations of test patterns on the 'borderline' of resolution have been re-evaluated. Two draft USA standards for optical density have been written. We are cooperating in the revision of existing national and international standards for films for permanent records and the storage conditions for the preservation of such film records and the preservation of colored photographs. A study of the theory of optical wedges has been completed and will be reported to the Optical Society of America in March. We sent a delegate to the meetings of the ISO committees on photography and cinematography in Moscow in June 1967. A paper 'A Half Century of Photographic Standardization in the United States' was presented at the annual meeting of the Society of Photographic Scientists and Engineers and is being prepared for publication.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0078, NUMERICAL CODE CONVERTER

E.C. PALASKY, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

The main objective is to determine the feasibility of designing a practical field instrument for measuring humidity based on the adiabatic saturation equation. Such an instrument would be useful in meteorology, particularly when an accurate and portable instrument is needed. It has the potential of extending the accuracy of the psychrometric method by about one order of magnitude.

The plan is to fabricate a prototype instrument, using dewars to insure adiabatic conditions; resistance thermometers, thermocouples, thermopiles or thermistors for temperature measurement; continuous automatic water feed to the wicking; constant flow sampling; and heated- air techniques to prevent freezing of the wicking. Tests will be performed using the NBS two-pressure generator as a source of known humidity.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0079, WATER CURRENT METERS

F.W. RUEGG, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

To provide calibration service for water current meters to the U.S. Geological Survey. The provision of this service is one way in which NBS meets its responsibility for providing the basis for accurate and uniform mechanical measurements throughout the Nation's scientific community, industry and commerce.

Water current meters are towed through still water at various constant speeds from 0.25 to 8.0 feet per second to determine the relationship between the speed and the revolutions per second of the meter turbine. The relationship is usually given by one or more straight line equations.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0080, NAVAL AIRCRAFT LIGHTING

T.O. TWIST, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

Objectives: 1) The development of standards, instrumentation and measurement techniques in the field of photometry to satisfy the updating of Naval Aircraft lighting specifications, 2) The monitoring of such specifications to insure that they remain abreast of the state of the art techniques, 3) The development of specialized lighting equipment with responsibility up to installation and test on aircraft to demonstrate feasibility, 4) The establishment of and the monitoring of photometric test facilities in government and the aircraft industry to assure correlation of measurements between laboratories, and 5) The technical monitoring of research, development, and human factors contracts as directed by the project sponsor. The functions of the project are germane to the NBS mission in that they closely parallel areas of photometry and colorimetry in which the Bureau has an interest, particularly in the development of low-level photometric reference standards, instruments, and measuring techniques used by industry. This is NBS Mission Component 1.6, Research and Development for another agency.

Approach: This is a continuing project and the approaches for solving the broad objectives outlined are varied. The problems can be classified as follows: 1) The development of standards, instruments and test methods and 2) Services provided the sponsoring agency. As for the standards, a continuing program is carried out for improving the source, instruments and methods employed in measuring the photometric characteristics of aircraft instruments and lighting equipment and the dissemination of this information through reports, specifications, and the participation in professional societies. The services accrue directly to the sponsor and the urgency for completion of any task undertaken is established by that agency. These services include the monitoring of specifications and technical aspects of contracts, as well as the development of prototype lighting equipment for exploring new concepts, and the furnishing of technical advisory services.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0081, HUMIDITY STANDARDS AND MEASUREMENTS

A. WEXLER, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

The development of suitable primary and secondary standards for the calibration of humidity equipment; the development of calibration techniques; and the investigation of properties, constants and behavior of water vapor and water vapor-gas systems. This project falls within the National Bureau of Standards mission to develop and maintain the national stands for physical measurement, to develop transfer standards and standard instruments and to undertake research in support of the above.

(1) Research and development is being conducted toward developing and adiabatic psychrometer that could be used as a secondary or field standard. (2) An investigation is being made of the effect of pressure of air on the saturation mixing ratio and on using the results for computing f-factors and interaction virial coefficients. (3) Research is being undertaken to extend the range of the National Bureau of Standards gravimetric hygrometer.

Air water content affects evaporation from rivers, ice, oceans, etc. Need to know water content in pressure suits and sealed submersibles. Weather Modification forecasts radio propagation (i.e., Navigational need).

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0082, AEROLOGICAL INSTRUMENTS

A. WEXLER, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

Development of improved instrumentation for measurement of such parameters as humidity and condensation nuclei for the study of weather modification and for cloud physics investigations. This project falls under the mission of the National Bureau of Standards to conduct research on basic measurement techniques and instrumentation. It should lead to improved instrumentation of increased accuracy for obtaining better weather forecasts, better understanding of cloud physics, and of the problems associated with atmospheric refractive index as it affects radio propagation.

A microwave hygrometer for field use consisting of two microwave cavities operating at 12 GHz, one cavity flushed with test gas and the other containing dry gas has been developed and is undergoing test. It will then be field tested.

Reporting Interval: March 16 to December 31, 1967.

Laboratory operational and electronic tests were completed on the microwave hygrometer. An electronic calibration was obtained of read- out vs. frequency. The instrument operates continuously and unattended. It has a total range of 100 N-units. The read-out, in the form of a trace on a strip-chart recorder, can be selected so that full scale corresponds to dewpoints of plus 40 degrees C to minus 50 degrees C, minus 5 degrees C to minus 50 degrees C or minus 30 degrees to minus 50 degrees C. Extensive humidity calibrations and field tests remain, to determine the operational characteristics of the instrument.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0083, HUMIDITY SENSORS

A. WEXLER, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

Tests on the long-range stability of the barium fluoride element were performed over a nine-month period. During this time, the element maintained its calibration to plus or minus 10% RH. A method was developed of measuring the surface temperature of the element by means of a vacuum-deposited palladium film. This film has a resistance of 50 ohms, and a temperature coefficient of .0033 (compared to a bulk coefficient of .0038). The element was used in a cooperative field experiment at Davis, California, with the University of Wisconsin and University of Washington to measure water vapor flux. Comparisons with a lysimeter yielded agreements in flux of 25 to 50%. A paper entitled 'Study of the Storage Stability of the Barium Fluoride Film Electric Hygrometer Element' was published in the NBS J. Res., 71C, 199 (1967).

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0084, HUMIDITY CALIBRATION

A. WEXLER, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

To provide calibration service for reference quality humidity instruments to the public and other Government agencies. The provision of this service is one way in which NBS meets its responsibility for providing the basis for accurate and uniform humidity measurements throughout the Nation's scientific community, industry and commerce.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0085, APPLICATION OF NUCLEAR TECHNIQUES TO MARINE MINERALS TECHNOLOGY

W. CAMPBELL, U.S. Dept. of Interior, Bureau of Mines, *Washington, District of Columbia* 20240

The Bureau of Mines marine minerals research program includes a study to determine the feasibility of nuclear and radioisotope techniques for both the delineation and characterization of marine mineral deposits, and the control of mining operations. Thus far, the effort has been concentrated on in situ activation analysis techniques. Elemental analyses were performed on four types of sea floor minerals of potentially commercial value: phosphorite, manganese nodules, sand (spiked with gold), and red clay. Elemental concentrations were determined by characteristic radiation emitted after irradiation by neutrons of different energies and at different flux levels.

The project was intended to serve as a start for a long-range program designed to produce, by about 1970, a Mineral Detection Probe. This instrument package will be built to probe, from sea floor to bedrock, the vertical dimension of an unconsolidated mineral deposit and provide at least semi-qualitative and, hopefully, quantitative analyses. The system will not require the drilling of a hole prior to its use; therefore, the speed of evaluating a submerged beach or stream placer mineral deposit will be greatly increased and the total exploration and evaluation cost considerably decreased. For this reason, the probe is thought to have eventual commercial possibilities.

SUPPORTED BY U.S. Atomic Energy Commission

8.0086, ULTRAVIOLET ABSORPTION AND LUMINESCENCE

W.R. HEMPHILL, U.S. Dept. of Interior, Geological Survey, *Washington, District of Columbia* 20242

Development and testing of the Frauenhofer Line Discriminator for marine geologic and hydrologic studies.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

8.0087, NUCLEAR OCEANOGRAPHIC TECHNIQUES

N. ANDERSON, U.S. Navy, Research & Dev. Department, *Washington, District of Columbia*

This is a jointly sponsored program concerned with the evaluation of proposals and experimentation on various isotopic techniques for the measurement of oceanographic parameters. Previous unofficial cooperation led to the Deep Water Isotope Current Analyzer and the Nuclear Sediment Density Meter. The Naval Oceanographic Office will perform such tasks as: 1. Conduct studies and experiments on the applications of isotopic techniques to the measurement of oceanographic parameters. The studies and experimentation will be conducted both in the laboratory under controlled conditions and at sea under operating conditions. In addition, some isotopic techniques and systems from other DID contractors will be introduced into this joint program. 2. Conduct studies and experiments on the Nuclear Sediment Density Meter in order that it can be modified to best meet Navy requirements. 3. Re-analyze and evaluate the Deep Water Isotope Current Analyzer in order to determine its full potential in naval oceanographic applications. Comparisons with conventional current sensors will be made. 4. Assist DID in evaluating new oceanographic proposals. 5. Exchange information with DID in fostering new techniques. 6. Make recommendations for Navy utilization of isotopic techniques found to advance the state-of-the-art. 7. Assist DID in maintaining liaison with other branches of the Navy for planning conferences, etc., both classified and unclassified.

SUPPORTED BY U.S. Atomic Energy Commission

8.0088, VISIBLE REGION INSTRUMENTATION FOR OCEANOGRAPHIC SATELLITES

J.W. SHERMAN, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objectives: (1) To investigate and evaluate all visible region passive instruments for over-water surveying and (2) to delineate which oceanic features can be observed by visible region instrumentation and ascertain optimum specifications for films, filters, and instrumentation.

Approach: (1) A continuing review of the state-of-the-art for visible regions instruments to observe ocean phenomena will be maintained. (2) Planned experiments over ocean test sites to test new instrumentation will be conducted. (3) Plan and execute experiments using airborne platforms to acquire and evaluate data for various ocean features (shoals, currents, bottom topography, sediment distribution, etc. a. Sensors - 1. Color and multiband camers. b. Proposed Contractor - Experimental Astronomy Lab., Massachusetts Institute of Technology, c. Allocation of Resources - Manpower 50%, Overhead, 50%.

Problem Addressed: Controlled experiments over the ocean are difficult to achieve and information, at present, is minimal. Film- filter tests need to be expanded for environmental measurements (currents, temperature, water mass identification) and the use of targets and controls for resolution and contrast loss is needed. Test sites, transportation, and control of aerial and surface data require difficult planning and execution. MIT has a good start on resolving these problems.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

8.0089, HYDROGRAPHIC SURVEY TECHNIQUES

R.L. WHEATLEY, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objective: Develop improved techniques and equipment to accelerate the collection and improve the quality of hydrographic data to meet DOD needs for the production of hydrographic and amphibious combat charts for support of various naval weapons. Data acquisition will be accelerated by at least a factor of five. Scheduled development extends through FY 73. With present methods only 300 miles of survey lines can be accomplished in one day by one survey ship. The new surveying techniques and equipment will accomplish 1500 miles of survey lines per day per ship. This effort is directed toward solving problems within the scope of mapping, charting, and geodetic functions as defined in DOD studies and in the report, June 1966, published by the panel on oceanography of the President's Science Advisory Committee.

Approach: Various sensors, techniques, and platforms for acquisition of hydrographic data will be investigated and tested. Sensors for both direct measurement and photogrammetric measurement of water depths will be investigated. The performance and suitability of the sensors when installed aboard high speed platforms will be determined. Sensor/platform utility will be determined for various applications and integrated with the optimum positioning system to upgrade the quality of hydrographic data. These investigations will lead to development of operational systems.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0090, DESIGN AND DEVELOPMENT OF OCEANOGRAPHIC INSTRUMENTATION

S.J. NISKIN, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124 (NONR)

Objective: To support oceanographic research relevant to Navy requirements a need exists for new and improved instrumentation for making measurements at sea. The aim of this research is to design, construct and test new devices for use in research and surveys.

Approach: A recently designed combination STD (Salinity, Temperature, Depth) and water sampling rosette is being constructed and field tested. A neutrally buoyant horizontal current-profile array of directional inclinometers also is being developed and tested to study water transport. Improvements are being made on a vertical current-profile array to permit recording of the array configuration for periods of at least 36 hours.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0091, DEVELOPMENT OF A SIMPLE UNATTENDED PYCNOCLINE FOLLOWER

W. DUING, Univ. of Hawaii, Graduate School, *Honolulu, Hawaii* 96822

It is planned to construct a simple unattended pycnocline follower which consists of an anchored neutrally balanced float. The first test of the equipment will be carried out in local Hawaiian waters. An observational program at the Line Islands region is designed to test the relationships between the depth of the pycnocline, solar radiation and wind stress.

SUPPORTED BY U.S. National Science Foundation

8.0092, DEVELOPMENT OF AN INSTRUMENT FOR MEASURING THE CONCENTRATION OF DISSOLVED OXYGEN IN SEA WATER IN SITU

V. GRAEFE, Univ. of Hawaii, Graduate School, *Honolulu, Hawaii* 96822

For the planned investigations of the interaction of water masses, of variations of the oxygen minimum layer, and of the oxygen concentration close to the bottom of the sea, an instrument is needed that will measure the oxygen concentration in situ in great depths. Such an instrument is not available, but the addition of telemetering equipment to an existing shallow water oxygenmeter that has been modified as required will result in an instrument that is capable of measuring O2 concentrations well below the O2 minimum layer. The resulting instrument will be tested and used in the ocean near Hawaii.

SUPPORTED BY U.S. National Science Foundation

8.0093, OIL MONITOR INSTRUMENTATION

UNKNOWN, Illinois Institute of Technol. , Graduate School, *Chicago, Illinois* 60616

PURPOSE: To develop an instrument which will monitor and record the oil content in shipboard bilge and ballast water discharge to permit the enforcement of the International Convention for Prevention of Pollution of the Seas by Oil (IMCO).

DESCRIPTION: The instruments must be capable of consistently detecting oil or oily residue in shipboard discharge at concentrations of 100 parts of oil in a million parts of water. The investigation has explored detection methods, including those used in laboratories, to develop detection instruments capable of functioning in the severe marine environment. The device now under development uses an infrared absorption technique to measure the difference between the input and output energy of the discharge. The difference is equivalent to the energy absorbed by the oil. Originally, research was aimed at the 3.4 micron energy region where hydrocarbons have a sharp absorption peak, but problems with opaqueness of water caused a change to the 1.6 micron region.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0094, X-RADIOGRAPHIC AND ELECTRONIC FLUOROSCOPIC EQUIPMENT

A.F. RICHARDS, Univ. of Illinois, Graduate School, *Urbana, Illinois*

This grant will provide toward the total estimated cost for a Norelco 150 MX x-ray machine with electronic fluoroscopic display apparatus and a specimen handling system. It is anticipated that the fluoroscopic display feature, which obviates the need of highly skilled radiologists, will pay for itself in the first three to five years of operation.

The first specific use of the equipment will be for the study of deep-sea sediment cores in which a Polaroid photograph of a lens magnified, image intensified display will record the optimum radiographic image for each portion of the sample tube x-rayed. The very slight degradation of picture quality by this method, compared to conventional film radiography, is not expected to be important.

The x-ray machine will feature simplified controls and an automatic tube load mechanism. The image intensification tube will have dual field feature giving a choice of nine inch field or electronic expansion of the central six inch field to nine inches. The system also has capabilities of stereo and color radiography.

SUPPORTED BY U.S. National Science Foundation

8.0095, TRANSDUCER RESEARCH

J.N. DAVIDSON, Westinghouse Electric Corp. , *Annapolis, Maryland* 21204

The research and development of a deep submersion spherical transducer was initiated. It will be continued during 1968 because of its potential as a deep omnidirectional target or receiver over a broadband of frequencies. No other shape or configuration has this characteristic. The first sphere that was tested for verification of design, failed in dynamic stress. An analysis showed that the sphere was faulty in construction since failure occurred at a stress far below the allowable dynamic stress.

Objective: To further the state-of-the-art in the field of low frequency sources and receivers of acoustical radiation. Also, to extend the understanding of mutual coupling effects in multielement arrays.

Approach: Research work and testing will continue in the areas of improved underwater encapsulating materials and techniques, sealing techniques, absorbers, decoupling techniques, and other mechanisms applicable in general to underwater acoustic transducers.

The principal research effort for 1968 is in the area of low frequency, high power, high efficiency Tonpilz transducer elements. One phase will investigate an element suitable for use in a planar or conformal surface ship array and a second phase, an element suitable for use in a deep-diving submarine array. In conjunction with research projects carried on by other groups, it is hoped that these transducers can be wed to the amplifiers to obtain subsystem optimized for power handling, efficiency, bandwidth, and element interaction.

Studies will also be carried out on the Cassegrain principle as applied to small acoustic transducers for high frequency surveillance.

Work previously begun on the composite cylindrical transducer, the spring-mounted, free-flooded Tonpilz element, the disc bender transducer, and the planar array study will be continued and/or completed. It is also planned that a study be carried out in small tank calibration techniques and array mutual coupling effects. It is further hoped that the hybrid computer (Underseas) research into element design and analysis can be extended to cover arrays of elements with mutual coupling or interaction effects included.

SUPPORTED BY Westinghouse Electric Corporation

8.0096, ADVANCE SONAR SYSTEMS

T.G. DELL, Westinghouse Electric Corp. , *Annapolis, Maryland* 21204

Objective: To further the state-of-the-art in high resolution and special purpose sonar. Also to extend the understanding of limited warfare sensor requirements.

Approach: Research work and testing will continue to provide improved special purpose and high resolution sonar equipment. Investigation will determine whether the hydrofoil sonar and the extended focal length transducers conceived in 1967, under UN-67-3R, have application to the special requirements of limited warfare.

The principal research in 1968 will be in three main tasks: namely, (1) completion of the feasibility model of the hydrofoil sonar initiated in 1967; (2) study and testing of new techniques leading to extended focal length high resolution sonar; and (3) study of existing devices and techniques that have application for display of high resolution sonar data.

The high resolution, high data rate hydrofoil sonar initiated in 1967 will be completed and testing will be conducted in the Acoustic Test Facility. If successful, a co-operative testing program on a hydrofoil will be pursued. The sonar technique also has application as obstacle avoidance sonar for manned submersibles.

Investigation into several potential techniques to increase the focal length of focused transducers will continue. Solution of the problem is required for reconnaissance sonar applicable to swimmer delivery vehicles, and the riverine warfare.

Present devices used to display high resolution side looking sonar are either of extremely limited performance or extremely complex. A study will be made of state-of-the-art techniques and devices to determine if improvements can be devised to provide a quick access, high resolution, high contrast, and economically feasible device.

SUPPORTED BY Westinghouse Electric Corporation

8.0097, NOISE LIMITATION UPON AEROMAGNETIC MEASUREMENTS

S.J. BANK, Roff Analytic Study Assoc. , *Silver Spring, Maryland* 20910

Objective: To acquire additional basic knowledge of the extent to which airborne magnetometers are physically limited by various forms of natural background noise.

Approach: Refine Methods for obtaining geologic noise spectra from the total magnetic field, and conduct detailed analyses of the effect of the ocean surface upon magnetic gradients.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0098, SUPERCONDUCTING MAGNETOMETER SYSTEMS EVALUATION

J. MICOL, Arthur D. Little Incorporated, *Cambridge, Massachusetts*

This task is to perform a Superconducting Magnetometer Systems Evaluation in order to determine whether the development of such devices will materially benefit the U.S. Navy. Several designs for these magnetometers are based upon phenomena occuring in thin superconductive films. This evaluation will combine (1) the operational usefulness of such very sensitive field and gradiometer magnetometers, (2) the limitations on performance of these devices, (3) realistic specifications which can be established for a new airborne operationally useful magnetometer and (4) based on the foregoing, the identification of areas in which research and development are required, the general nature of the program and their estimated costs and durations.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0099, INERTIAL TECHNIQUES

D.P. KELLY, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139 (NONR)

The goal is to apply modern inertial techniques to the measurement of the change in horizontal velocity with depth. Envisioned is a free- falling, recoverable, hydrodynamically-tuned vehicle which when acted upon by horizontal currents will be translated sideways without rotation. The horizontal displacements would be sensed by an inertial system and stored together with depth information. The coming year's work will consist of laboratory experiments and of design of an accelerometer system for a prototype field model. When the limit to which a free-fall probe can be tuned for vertical stability is discovered, the decision can be made as to the necessary requirements for additional internal gyroscopic stabilization of the accelerometer platform.

The development of a successful system would permit accurate measurement of vertical profiles of horizontal currents without mooring or accurate navigation. Such measurements would be useful in deep water engineering tasks, in ascertaining the mixing and dilution rates of adjacent layers, and in determining space distribution of time changes in the sound propagation field.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0100, AN INVESTIGATION OF THE S/N FATIGUE LIFE GAGE

G.F. LIVINGSTON, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

The S/N fatigue life gage is a small sensor which is similar in appearance to a foil strain gage. The S/N fatigue life gage is bonded to the surface of a mechanical structure using standard strain-gage techniques. The S/N gage changes resistance permanently as a continuous function of fatigue experience. This gage was developed by Mr. Darrell R. Harting of the Boeing Company, Seattle, Washington. The gage is produced commercially by Micro-Measurements, Inc. and distributed by W. T. Bean, Inc., Detroit, Michigan.

This investigation describes the results of a series of reverse bending tests on S/N fatigue life gages which were mounted on Ti-6Al- 4V titanium specimens. Each S/N gage was subjected to various constant strain loadings for varying numbers of cycles.

The results of this investigation show that the performance of the S/N fatigue gage under random cyclic loading is predictable. Another result of the tests indicates that the S/N gage experiences an above normal increase in resistance well in advance of actual gage failure. Finally it was observed that a decrease in S/N gage resistance will occur: immediately after the mean cyclic strain level is lowered; and whenever the gage is subjected to any substantial rest period.

SUPPORTED BY Massachusetts Institute of Technology

8.0101, MARINE GRAVITY

C.G. WING, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139 (NONR)

This task will continue the construction and development of a new shipborne gravity meter that is expected to have a higher operating accuracy and lower cost than do existing competitive meters. The system consists of a double vibrating string accelerometer, which is a modification of surplus accelerometers developed for the space program, mounted on a Sperry Mark 19 gyrocompass. Work this year will include improving the instrumentation and evaluating the meter at sea on different ships and in different sea states. Instrumental developments include finding the simplest solution to the Eotvos gravity errors associated with marine navigation.

Knowledge of the earth's gravity field is important for calculating the deflections of the vertical, needed for navigation. This task attempts to develop a meter that will provide more accurate gravity measurements at a lower cost.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0102, DEVELOPMENT OF FISHNET BATHYKMORGRAPH

J.E. CROSSEN, U.S. Dept. of Interior, Biological Laboratory, *Woods Hole, Massachusetts*

Purposes: To develop an instrument system that can measure the time, duration, and depth of each haul made by New England Groundfish fishermen as a precise measure of fishing effort.

To provide acceptable hardware for a model of a standard system that will minimize the total cost of the complete operation from data collection to the printing of the final format. Specifically, to provide 20 fish-bathy-kymographs (FBK's) (DSE) for analogue readout including calibration equipment, and spare parts kits in accordance with contract 014-17-0007-820 and the assurance that the acceptance criteria have been met.

Approach: Contract development of the model system to a commercial contractor (Geodyne Corp.) with a Bureau coordinator and project leader (Mr. Crossen) in the Lead Laboratory (Woods Hole). Oceanographic Instrumentation will coordinate the efforts of the Branches concerned with this project. A reliability engineering support contractor (Arine Co.) will supply services at prescribed check points.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0103, SHIPBOARD GRAVITY SENSOR AND GYROCOMPASS

C.O. BOWIN, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

A Sperry Mark 19 gyrocompass will be modified into a Mark 19c configuration and a Bosch Arma vibrating-string accelerometer will be mounted aboard ship so as to function as a sea gravimeter similar to that developed by Von Arx and Wing.

SUPPORTED BY U.S. National Science Foundation

8.0104, INSTRUMENT STUDIES

D.C. WEBB, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

The objective of this task is to provide advanced and comprehensive engineering support for a wide range of scientific and observational programs. This support will be achieved through the evaluation of promising but unproven techniques, acquisition and testing of new components, and investigation of causes of failure. Work will be done in the laboratory and in the field.

It is expected that this work will generally benefit the program at the institution by improving new instruments. This in turn will improve competence available to the Navy for general oceanographic efforts.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0105, INSTRUEMTATION FOR LAKE CAYUGA HEAT RELEASE STUDY

D.H. BOCK, Cornell Aeronautical Lab. Inc. , *Buffalo, New York* 14221

Instrumentation has been designed, developed, calibrated, and installed for recording temperature profiles and flow rates at several points in Lake Cayuga in the vicinity of a fossil-fueled power plant. Four buoys and one rigid pole in the lake were used for the instrumentation installations, from which temperature and flow rate information is transmitted to shore via coaxial cable. (This cable also carries power for the instruments and low frequency command signals for sampling various instruments at the buoys and the pole.) The signals which measure the flow rate and temperature are frequency modulated with an analog of the variable being measured. Time division multiplex is used for sampling of up to 24 signals from each of the buoys and the pole and to permit transmission of the data via the one coaxial cable. At the shore, the data can be extracted and recorded in digital or analog format. A digital-to-analog converter is available to permit monitoring of signals on a paper chart recorder. The sampled signals are connected to a telephone line to permit access to the data at a central location where equipment maintenance can be initiated, when necessary.

SUPPORTED BY New York State Electric & Gas Corporation

8.0106, STUDY OF PROBABILITY OF DETECTION AND FALSE ALARM RATE OF FREQUENCY ACOUSTIC TELEMETERING SYSTEM

R.A. HELTON, Raytheon Company, *Portsmouth, Rhode Island*

The penalty for a false actuation by an acoustically-controlled underwater oil well may be drastic in terms of the human lives and capital resources which could be lost. A study of the effective false alarm rate that may be achieved with an acoustic frequency diversity telemetering system, consistent with a high detection probability, has been completed. An acoustic link must face hazards of high noise levels, multiple reflections, reverberation, and temperature inversions. Our study has evaluated these basic phenomena theoretically within the limits of our knowledge of the statistics of the noise field, of the variability of the medium, and the likelihood of particular forms of man-made interference. The system has been tested at sea, and data pertaining to the assembling of background statistics has been collected.

We have demonstrated that systems may be designed with an acceptably low risk of false actuations, while achieving positive detections reliably. The study indicates that only modest power would be required to achieve satisfactory operation at ranges which permit operation over the full extent of the Continental Shelf.

SUPPORTED BY Raytheon Company

8.0107, DEVELOPMENT OF A SENSOR, INSTRUMENTATION AND COMMUNICATION SYSTEM FOR A DEEP OCEAN MANNED HABITAT (ATLANTIS)

O.H. JACKSON, Raytheon Company, *Portsmouth, Rhode Island*

Technical Description: Conceptual development of electronic systems for a manned habitat for occupation of the ocean floor at 6,000 feet was initiated. Particular emphasis was directed to: communications between habitat and surface; communication between habitat and telechiric devices; communications between men in the hyperbaric environment and the habitat; fail-safe emergency communications on several levels; navigation systems for precise localization and elevator mating; remote positioning and control of telechiric devices; long range acoustic sensing systems; sensors for the acquisition of physical, chemical biological and geological data; data handling to ensure crew safety; data handling to process and analyze the sensor information.

This effort involved basically the evolution of the electronic systems necessary to support a long term manned mission on the edge of the shelf or on the mid-Atlantic ridge.

SUPPORTED BY Raytheon Company

8.0108, FEASIBLITY STUDY FOR A GATED-LASER, IMAGE-AMPLIFIER UNDERWATER VISION SYSTEM

T.W. SMITH, Raytheon Company, *Portsmouth, Rhode Island*

The growth in man's ability to exploit the oceans has made obvious the need for systems to identify underwater objects and to provide information for the direction of work. Underwater television provides a limited capability which must be extended for operation in turbid water. This program accomplishes a significant performance improvement through the application of a blue-green YAG laser for illumination, a Raytheon night vision image converter, a range gate for selecting the range of interest and a television system for delivery of the resulting image to a remote viewer. The program has included analytical study and experimental verification of results.

SUPPORTED BY Raytheon Company

8.0109, EXPERIMENTAL HIGH RESOLUTION SUB-BOTTOM PROFILING SYSTEM

G.M. WALSH, Raytheon Company, *Portsmouth, Rhode Island*

An experimental replica correlation echo sounder system is being developed, including transducer, power amplifier, receiver and signal processor. This system will experimentally verify performance of large time-bandwidth product (WT) signal processing for the measurement of depth and sub-bottom profiling, with potential signal processing gains of 23 db. The increased signal energy provided by the large WT signals will significantly improve measurement resolution and provide capability for penetrating into the ocean floor for examination of sub bottom layering. In addition, the constant false alarm rate (CFAR) receiver characteristics will improve the ability to automatically measure the depth for direct input to computer data processing, simplifying the data collection and reduction procedure.

SUPPORTED BY Raytheon Company

8.0110, MODIFY 19 OCEAN BOTTOM SEISMOGRAPHS AND CONDUCT TESTS WITH THE DEVICE

UNKNOWN, Texas Instruments Incorporated, *Dallas, Texas* (AF-19-628-05890)

Technical Objective: The contractor shall incorporate certain improvements and refinements in the design of the ocean bottom seismograph to increase its performance capabilities. In addition, a series of tests will be performed to evaluate the improved system.

SUPPORTED BY U.S. Dept. of Defense - Air Force

8.0111, ADULT SALMON BEHAVIOR STUDIES IN RIVERS AND AT DAMS (SONIC TRACKING)

J.H. JOHNSON, U.S. Dept. of Interior, Fish Passage Res. Program, *Seattle, Washington*

This project seeks information which will contribute to a sound assessment of the effect of reservoirs and dams on anadromous fish runs, specifically on adult salmonids returning to Columbia River system spawning areas. Such an assessment requires an accurate knowledge of migration timing and spawning area locations before dams are constructed, and of the amount and nature of mortality resulting directly from fish passage over dams.

The project's primary research tool at present is the sonic fish tag, a miniature high frequency sound transmitter attached directly to the fish. Sonic tagged fish can be tracked individually from boats, their continuous movements noted in precise detail, or their progress and dispersion upstream can be measured by means of automatic recording monitors placed at intervals along the shore above a tagging site. The latter system is being utilized to study migration timing and population distribution in the Snake River and its tributaries from its mouth to a point 200 miles upstream. Phases of this work relating to timing of adult migration are performed cooperatively with personnel of the program titled 'Adult Migration Rates'. A study of adult salmon mortality caused by fish being swept downstream through dam spillways is in progress at Ice Harbor Dam, employing both individual tracking and a system of monitoring receivers installed in each spillway gate opening.

A study of the freshwater homing behavior of migrating salmonids is planned, using sonic tracking techniques in the field in combination with laboratory studies, already in progress, of sensory response and sensory organ anatomy and physiology.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8G. EQUIPMENT DESIGN AND STANDARDS

(includes Fishing Gear and Transducers. See Also Chapter 8f Instrumentation)

8.0112, COOK INLET ESCAPEMENT ENUMERATION STUDY

A.S. DAVIS, State Dept. of Fish & Game, *Juneau, Alaska*

Because of the silty or glacial conditions of the major sockeye salmon systems in Cook Inlet, it is necessary to obtain escapement information by other means than counting towers, aerial or foot surveys, or other visual methods.

Bendix Pacific Corporation with the financial assistance of the State of Alaska, has developed a sonar counter which will enumerate passing fish. The experimental model of the unit was tested by the corporation on the Kvichak River in the summer of 1965. Escapement estimates of red salmon by the machine matched the visual estimates in the same time period with a 3.1 percent error. The experimental sonar unit, which is the property of the State of Alaska will be utilized for escapement enumeration in 1966. A second unit will be purchased so that both the Kenai and Kasilof River escapements can be estimated.

During the first of June, a two-man crew will investigate possible sonar sites on the Kasilof River. with the sonar unit should have a steep, sloping bank directly in front of the transducers which levels off and slopes gently to the stream bank. Migrating salmon generally will pass close to the steep bank directly in front of the transducers, when the bottom contour is as mentioned above. A sonar site on the Kenai River was located during 1965. The sonar unit will be installed on the Kenai River June 1, and on the Kasilof River as soon as a suitable site can be located.

Each of these installations will be operated by one temporary employee. The assistant project leader and a third temporary employee will sample upstream migrants in the immediate area of the sonar counter. Sampling will be conducted on each stream every other day. Lengths and scale samples will be taken to establish life characteristics of the sockeye salmon runs. Sonar counting and sampling of the adults will cease August 15 or as close to that date as the escapement dwindles.

Part 1 of 3. Part 1 of 3.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

8.0113, KING CRAB SAMPLING GEAR STUDY

G.C. POWELL, State Dept. of Fish & Game, *Juneau, Alaska*

The foremost objective of this phase of a long range study of the reproduction of king crab in the Kodiak Island area is to organize a sound program for sampling king crabs on the continental shelf. Assessing the capabilities of various types of capture gear is important to guarantee adequate sampling methods. Each of the various types of capture gear, e. g. tangle nets, pots, trawls, SCUBA diving, etc., will be investigated for their efficiency as sampling gear for all segments of the crab population in various environmental areas. The experimental fishing will be largely conducted from charter vessels using experienced fishermen as fishing crews.

Commencement of the actual determination of the offshore and inshore king crab spawning grounds off the east side of Kodiak Island will also be conducted utilizing the capture gear shown to be the most effective in capturing breeding crabs.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Alaska State Government

8.0114, GEAR EVALUATION

J.R. HOLLOWAY, Amer. Somoa Dept. of Agric., *Pago Pago - Tutuila, American Samoa*

Objectives - Test various types of standard fishing gear such as handlines, fish traps, seines, etc. to determine their efficiency in American Samoa waters and what modifications if any are necessary.

Procedures - Test various standard gear aboard small sampan, evaluating by total catch and catch per unit effort. Record types of gear used, how manufactured and results of modifications. Pertinent data collected in Phase II will be applied in all evaluations.

Work Schedule - Initial period approximately February 1, 1967 to June 30, 1967 Phase to be extended for at least 1 year to properly evaluate effects of seasonal and areal variations of species and oceanographic conditions.

Location of Work: Major Islands of American Samoa

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
American Samoa Government

8.0115, TESTING AND EVALUATION OF HIGH-RESOLUTION ACOUSTIC SUBBOTTOM PROFILER THROUGH MODIFICATION OF OFF-THE-SHELF COMPONENTS

H.L. HESS, U.S. Dept. of Interior, Marine Min. Technol. Ctr., *Belvedere - Tiburon, California* 94920

During FY 68, a suite of instruments and modular components for bottom and subbottom acoustic profiling were acquired and initial modifications made to develop an advanced-design, high-resolution acoustic subbottom profiling system applicable to detailed delineation of shallow water, heavy metal, placer type deposits. A new improved hydro-phone array has been designed and the electronic circuitry assembled. An advanced programmable subbottom profiling amplifier has been designed and fabricated to provide for programmable time-gain control, automatic gain control, and variable gain control for increased range, accuracy, and broader operating capability.

The acoustic subbottom profiling system has now undergone the initial phase of conversion to a high-resolution acoustic subbottom profiler required for detailed characterization of shallow water placer deposits. Additional modifications will now be made to perfect the universal electronic amplifier with programmable gain and time circuits to drive the seismic records; also to the hydrophone arrays and sound sources. The outlook is for greater sensitivity, faster towing speeds, and higher quality records.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0116, TESTING AND EVALUATION OF MAGNETOMETER/GRADIOMETER AND TOW VEHICLE SYSTEM

H.D. HESS, U.S. Dept. of Interior, Marine Min. Technol. Ctr., *Belvedere - Tiburon, California* 94920

This project involves field testing, evaluation and modifications of the Bureau owned magnetometer/gradiometer and specially designed underwater two vehicle which was designed and fabricated during latter FY 68. The principle of the marine gradiometer system in operation involves towing of the sensor system and continuously recording the difference in the magnetic field intensity measured at the two rubidium magnetometer sensors which are separated a known distance in the towing vehicle.

Possible use of the system in the magnetometer configuration, with one of the sensors acting as a mobile magnometer and the other as a base station transmitting the time variations in the earth's magnetic field to the mobile station by radio, will also be investigated.

Although present emphasis will be on heavy mineral placer deposits, possible application to heavy mineral lode deposits will not be overlooked. Other mineral deposits which may be associated with magnetic minerals will also be considered.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0117, MOVABLE OCEAN MEASUREMENT SYSTEM

D.M. BUCK, General Motors Corporation, *Goleta, California* 93017 (NONR)

A special hydrophone array with associated electronics will be constructed and mounted on the Perpendicular Ocean Platform (PO). The system will be tested at the Santa Cruz Acoustic Range Facility (SCARF). In addition, a study will be made to determine the optimum spectrum analyzer configuration to be used with the system. A development breadboard model will be constructed based on the results of this study.

APPROACH: Collect geophysical and sub-bottom acoutstic profiles;

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0118, ARCTIC SEISMIC TRANSDUCER EVALUATION

C.R. GREENE, General Motors Corporation, *Goleta, California* 93017 (NONR)

The U.S. Army Electronics Command has developed efficient seismic transducers which are used for various tasks where it is desirable to transmit signals using the ground as the conducting medium. The contractor will evaluate the effectiveness of these same transducers in transmitting, through Arctic ice, an acoustic signal to the ocean.

An efficient seismic transducer, capable of transmitting acoustic signals through an ice barrier to the sea water, would have Naval relevance in the areas of under-ice communications and navigation.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0119, TUNA PURSE SEINE NET

R.E. GREEN, U.S. Dept. of Interior, Fishery Oceanography Ctr., *La Jolla, California*

The objective of this project is to introduce to the fishery a more efficient type of gear than that which is currently in use. A new design of fast-sinking tuna purse seine net, has been developed and is now being constructed. The net will be completed by the end of 1968 and during the subsequent years, operational experiments will be made with it at sea. If the tests on chartered commercial fishing vessels are successful, the net will subsequently be loaned to non-- chartered tuna seiners for further tests and demonstration and acceptance by the existing fleet as an improvement over existing gear.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0120, CONSTRUCTION SYSTEMS

UNKNOWN, U.S. Navy, Civil Engineering Lab., *Port Hueneme - Point Mugu, California*

Objective: Develop the technological data required for the selection of specialized work equipment and tools to perform construction operations on the sea floor. Present construction in the ocean has been largely restricted to relatively shallow depths (200 ft) with most of the work being done from the surface by lowering prefabricated components. There are limitations to this method due the effects of surface environment on movement of the platform and due to the contraints imposed by current cable technology and weight handling devices. Under this task studies and experimental effort will be undertaken to identify the problems associated with ocean construction due to the above constraints and to investigate the feasibility of using subsurface and bottom construction systems such as a submarine work boat or a bottom crawler.

Work undertaken in this area will be used for support of advanced development in construction equipment and techniques.

Approach: Identify and analyze the construction functions required to develop a construction capability. Some of the major functions to be studied are weight handling, assembling methods and excavation and trenching. Having identified the restraints, the most optimum methods for performing these functions will then be formulated and analyzed. From this analysis candidate systems for performing the construction functions will be designed and evaluated to determine what further development is required.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0121, PRECISION QUARTZ CAPACITANCE PRESSURE TRANSDUCERS

N.L. BROWN, Bissett Berman Corporation, *San Diego, California*

The transducer being developed under this program is intended for numerous oceanographic applications where extremely high accuracy and sensitivity is required. This transducer takes advantage of the excellent elastic properties of quartz in conjunction with a technique for measuring capacitance which is extremely accurate and sensitive. This combination eliminates most of the sources of error common to other types of pressure transducers.

The transducer is in the form of two coaxial cylinderical elements fabricated in clear fused quartz. The diameter of the outer element is reduced slightly under the effect of pressure and the small deflection is detected by platinum electrodes deposited on the inside diameter of the outer piece and the outside diameter of the inner piece. The transducer capacitance is typically 75 picofarads at zero pressure and increases to 90 picofarads at rated pressure. This capacitance change can be utilized electronically in several ways which permit either a linear frequency change with pressure or a linear digital output. Existing prototypes exhibit accuracies of plus or minus .3 percent when utilized in oceanographic instruments and an accuracy of plus or minus .01 percent under laboratory conditions.

SUPPORTED BY Bissett Berman Corporation

8.0122, DEEP-SEA AUTONOMOUS VEHICLES, INSTRUMENTS, BASIC CONTROL DEVICES, AND SPECIAL COLLECTING GEAR

J.D. ISAACS, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038

This grant will provide for the continuation of work performed under NSF Grant GP-3349, The development and testing of deepgsea autonomous vehicles, associated instruments, basic control devices, and special collecting gear. These together constitute a further development of this relatively new approach to the gathering of oceanographic data and specimens.

The autonomous or free vehicle is a versatile carrier that transports the instruments to depth and returns them to the surface for recovery. The control devices program the vehicle and control the instruments causing them to perform their required functions. Specific instruments that have been so far developed under this program include a bottom fish trap, current meter, vertical and sampling parachute net. Also, control, release and flotation devices have been developed. The following instruments are proposed for research and development: an instrument to measure the basic mechanical (engineering) properties of deep-sea sediments, a bottom camera, bottom detrital gauge, gas collector, event recorder (a device that waits for long periods to record a rare event), gentle corer, large water sampler, and deep life support fish trap. The program of development works closely with investigators in the various fields. Thus, the instruments are simultaneously developed, tested and used in the acquisition of meaningful data. Two recent cruises collected 17 near-bottom current measurements in 2,200 to 4,000 meters in three different locations for periods up to 3 days, and made 14 fish-trap drops.

SUPPORTED BY U.S. National Science Foundation

8.0123, DIGITAL OUTPUT SURVEY DEPTH SOUNDING

E.C. BUTT, Raytheon Company, *South San Francisco, California*

Technical Description: The purpose of this project is to develop a high precision survey depth sounder with a range of 2 to 250 feet and 2 to 250 fathoms with necessary signal processing so that the depth soundings can be read out in digital form as well as recorded on a conventional electro-sensitive paper. Logic circuitry is provided to give four bit parallel 1-2-4-8 BCD code output for recording on magnetic tape or feeding directly into a computer.

The equipment is designed in splash proof cast casings and suitable transducers are provided either for mounting in a small sounding launch or on a large survey type vessel.

The system is suitable for interfacing with such position finding systems as Decca Hi-Fix and Cubic Corporation Autotape.

SUPPORTED BY Raytheon Company

8.0124, OIL - WATER SEPARATOR

UNKNOWN, Cuno Engineering Corporation, *Meriden, Connecticut* 06453

PURPOSE: To develop an effective shipboard oil-water separation system as a means to prevent pollution of the seas by oil discharged with ballast water.

DESCRIPTION: A land-based pilot system has been built and tested at the contractor's seawater test laboratory. Results to date have been successful, but only at a significantly reduced throughput. The filters have since been further modified to increase separation efficiency at higher flow rates and additional tests will be conducted.

Further investigations and tests have examined effects of oil concentrations, oil viscosity, flow rates, differential pressure, temperature, and filter cleaning speed. It has been found that oil concentration, mixture, flow rate and differential pressure across the filters are the major considerations in the separator development. Tests are continuing to provide data for design of a practical shipboard separator.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0125, SELF-REGULATING STEAM GENERATOR

UNKNOWN, Combustion Engineering Inc. , *Windsor, Connecticut*

PURPOSE: To develop an automatic Self-Regulating Marine Steam Generator having improved boiler control and performance characteristics and reduced complexity.

DESCRIPTION: The unit is an inherently self-regulating steam generator system with a series turbine mounted between the boiler drum and superheater providing combustion control based on steam demand. The boiler response time to meet changes in steam demand has been reduced by use of welded water-walls and minimization of heat absorbing boiler brickwork. The unit has feedwater control integrated as part of the self-regulating steam generation process and will provide complete automatic response to single lever propulsion control. It has capacity for a 20,000 SHP turbine propulsion ship. The unit is fully erected at NAVSEC, Philadelphia, and is undergoing a series of preliminary tests to determine operating characteristics.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0126, BIO-ACOUSTIC AND BIOLOGICAL SAMPLING GEAR STUDIES

W.I. ARON, Smithsonian Institution, *Washington, District of Columbia* 20560

This task covers the laboratory analysis of sixty collections taken with the Hardy Continuous Recorder, the International Indian Ocean Expedition plankton net and the International Cooperative Investigations of the Tropical Atlantic (ICITA) plankton nets. These samples were taken in the Indian Ocean during the round-the-world voyage of the USC&GSS Oceanographer. The catch data from the different samplers will be compared and related to acoustical data obtained from the ships EDO-PDR system and narrow-beam transducer sonar.

The volume reverberation of underwater sound in the oceans, caused by marine organisms, is of concern in marine operations. This study will provide new information on the sampling gear used to catch the organisms and will relate research equipment performance to the catches. Ultimately, this information is required for mapping or predicting areas of the oceans in terms of volume reverberation.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0127, STANDARDS FOR AUDIOMETRY

P.G. WEISSLER, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

Maintenance and improvement of Sound Laboratory facilities for the calibration of audiometric devices, such as earphones, bone vibrators, artificial ears and artificial headbones. Measurement of stability, distortion, and sound attenuation properties of circumaural earphones, accuracy of commercially available audiometer calibrators, and properties of artificial ears proposed as standards. Establishment of a cheap, accurate and fast audiometric earphone calibration service. For new types of audiometric equipment, investigations of their properties and development of calibration procedures. Determination of the mechanical driving-point impedance and sensitivity of artificial headbones proposed as standard devices for storing bone-conduction threshold data and for calibrating audiometric bone-conduction receivers. Participation in the work of USASI, IEC and ISO.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0128, ENVIRONMENTAL TEST AND EVALUATION

J.G. LARSON, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

Objective: 1. To perform acoustical and electrical tests, using pulse techniques, on tranducer models. 2. To measure acoustic and electrical properties of transducers under hydrostatic pressure. 3. To determine the acoustic properties of acoustic linings for use in acoustic tank. 4. To determine effects on transducer materials under loaded and unloaded conditions.

Approach: The basic approach for all test work is to outline the program, provide necessary equipment, coordinate and perform the tests, and prepare and submit the required reports. The approach in providing facilities is to study and survey needs and requirements , formulate basic designs and specifications, initiate and coordinate design actions and construction and/or procurement.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0129, DESIGN AND DEVELOPMENT OF NEKTON SAMPLER

J.F. HEBARD, U.S. Dept. of Interior, Trop. Atlantic Biolog. Lab. , *Miami, Florida*

Objectives: To design optimum gear for sampling tuna forage nekton capable of: (a) capturing and retaining the desired components of the nekton community, (b) sensing environmental variables at the time of sampling, and 'reporting' to the observer certain data relating to the behavior of the device itself (e.g., speed through the water, changes in sampling depth, amount of water strained, etc.)

Through consultation with hydrodynamics design engineers, new approaches to nekton sampling equipment will be sought. If feasibility studies develop a promising design, a prototype will be constructed and tested under controlled and field conditions. Construction and further use of 'production models' will depend upon the outcome of the latter trials.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0130, CHEMICAL EXPLOSIONS, PACKAGING AND HANDLING AT SEA

D.W. KOS, I I T Research Institute, *Chicago, Illinois* (DA49-083-05A-3198)

Technical Objective: To develop containers and techniques for detonation of underwater chemical explosions in the size range from 10-1000 tons. Provision to be made for controlled sink rate and capability to detonate to depths of 4000 feet.

Approach: Design modular containers in three size ranges; 10-40 tons; 50-200 tons; and 250-1000 tons. Conduct theoretical and laboratory studies to determine optimum explosive for use with containers considering cost, safety, ease of handling and minimum legal constraints, and compatibility with container material. Construct prototype containers and sea test including detonation.

Progress: Container design completed. Steel shell with diaphram to allow for compressibility and bouyancy chambers with calibrated flooding to provide pre-determined sink rate. Pressure fused for detonation up to 4000 feet. Instrumented for explosion time and depth. Aluminized ammonium nitrate slurry selected as explosive. Two 10-ton prototypes successfully tested off California coast in February 1968. A 250-ton container built, sea tested, and detonated in deep water off Aleutians on 5 September 1968. The 250-ton container was 20 feet in diameter and 50 feet long, with a hemispherical nose and a skirted stern. It had forward and aft bouyancy chambers and a 5,000 cubic foot explosive chamber. Three 30-foot pontoons were located at equal distances around the body for towing stability with the bottom pontoon flooded for ballast. The explosive chamber contained 250 tons of a slurry which produced a seismic output equivalent to the underwater detonation of about 340 tons of TNT. Associated instrumentation obtained detonation time and depth and provided redundant systems for increased reliability of detonation.

SUPPORTED BY U.S. Dept. of Defense - A.R.P.A.

8.0131, INVESTIGATION OF METHODS TO REDUCE SUCTION AND DISCHARGE LOSSES OF A PERIPHERAL COMPRESSOR

F.D. DUFF, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

Information concerning the improvement of performance of peripheral compressors is very inadequate. The objectives of this study are as follows: (1) to evaluate certain methods of suction and discharge loss reduction in peripheral pumps; (2) to determine the streamline pattern from measurable machine parameters and; (3) to determine the effectiveness of the stripper section in controlling high pressure carry-over flow and its effect on the through-flow rate at high Mach numbers.

Losses in the inlet and exit sections are a significant portion of the overall compressor inefficiency and can be reduced by proper design of these openings to conform to the machine streamline pattern and thus offering resistance to the flow.

The loss-reduction methods are evaluated and found to increase maximum efficiency by as much as 6 per cent. Streamline directions can be calculated from specific machine variables and conform closely with those observed. The stripper section becomes less effective at higher Mach numbers and as much as 14 per cent of the through-flow is lost through flow carry over.

SUPPORTED BY Massachusetts Institute of Technology

8.0132, A DESIGN PROGRAM FOR SUPERCONDUCTING ELECTRICAL MACHINES

D. GREENEISEN, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

This paper presents a procedure for the design of superconducting electrical machines. The magnetostatic field problem of a cylindrical superconducting machine is solved. Equations for the magnetic fields are developed, and from these, expressions for the various machine parameters are obtained. These expressions are adapted to a computer solution of the design problem. The computer program obtains the design parameters for a minimum volume machine design.

A design study for a typical marine electrical propulsion system is conducted. The results of this study indicate quantitatively the reduction in weight and space to be obtained in using superconducting electrical machines vice conventional electrical machinery. The study also presents some general characteristics of superconducting machines.

SUPPORTED BY Massachusetts Institute of Technology

8.0133, TRAWL DESIGN, MATERIALS AND METHODS

R.A. BRUCE, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Gloucester, Massachusetts* 01930

The primary purpose of this project is the development, testing and introduction to industry of new and improved trawling equipment. In the past, industry has been aided in its investigation and trials of different types of trawl gear both by Base instigation and by industry-State-Federal cooperative activities under PL 88-309. Current development activities now emphasize improving the wing spread and headrope height for existing nets as well as developing, testing and introducing an improved type of bottom trawl net.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0134, PELAGIC TRAWL

M.G. CORBETT, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Gloucester, Massachusetts* 01930

Research and development is to be continued to design a trawl system capable of capturing fish at any desired depth independent of vessel speed and warp length/depth ratio. Efforts are to be directed toward mechanical control of trawl door attitude to effect depth changes and the development of an efficient high lift/drag ratio trawl door.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0135, MECHANIZATION OF TRAWL GEAR

M.G. CORBETT, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Gloucester, Massachusetts* 01930

Concurrent industry-Bureau interest in mechanization of trawling gear is implemented by activities programmed under this project. Basic objectives are improvement to the safety, economy and efficiency of existing older trawl vessels. The immediate objective of current activity is the development of a device to automatically couple and uncouple the trawl doors from the towing warps during the setout and haulback sequences of the trawl operation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0136, GREAT LAKES GEAR RESEARCH

J. ELLIS, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Ann Arbor, Michigan*

The Region 4 Exploratory Fishing Base is responsible for the development of efficient and effective commercial fishing and research fishing techniques through virtually all of the freshwater commercial fish producing areas in the U.S. The fishing industry in this region is with few exceptions in an extremely depressed condition. A primary cause of this condition is the inadequacy of traditional fishing methods and equipment for meeting the present day situation from both resource and economic standpoints. Not only has the abundance of traditional commercial species changed markedly in most waters, but new outlets for low value species have been developing at a rapid pace in recent years. The paradox of having more fish than ever avaialble for commercial use and an ailing fishing industry is explainable only the failure of the industry to progress technologically relative to the development and use of equipment, instruments, materials, and systems that are necessary to keep abreast of changes in fish populations and in potential uses of fish.

Objectives of the Great Lakes Gear Research Program are to improve fishing techniques, to develop more efficient harvesting devices, and to demonstrate the application of appropriate methods for meeting unique production conditions, often in waters supporting important sport fishing activities.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0137, UNDERWATER ACOUSTIC HOLOGRAPHIC DISPLAY

R.K. MUELLER, Bendix Corporation, *Southfield, Michigan* (N00014-68-C-0338)

Objective: The Navy's interest in target classification, underwater object location, and the extension of underwater vision beyond the limits of range permitted by conventional light optics provides the incentive for this research. The application of lensless imaging (Holographic techniques) will be investigated using acoustic energy as the illuminant.

Approach: An investigation will be conducted in multiple element receiver arrays, multiplexing of signals electronically, and unique transduction techniques. Experimental hardware will be designed and constructed from which underwater acoustic holographic images will be obtained using photographic methods and a multi-element array.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0138, DEVELOPMENT OF UNDER-ICE HORIZONTAL SONAR SCANNING EQUIPMENT AND TECHNIQUES FOR LOCATING FISH SCHOOLS

C.R. BURROWS, State Dept. of Conserv., *Saint Paul, Minnesota* 55101

Objectives: 1. to adapt existing horizontal scanning sonar apparatus to under-the-ice commercial seining operations on inland lakes. 2. To demonstrate the gear and techniques to the local commercial roughfish seiners and promote its adoption in the industry.

Procedures: 1. Selection and acquisition of horizontal scanning sonar apparatus from among those currently offered to the industry by three different manufacturers. 2. Install this equipment on a sled or other snow vehicle for transportation to locations where fishing operations are being conducted. 3. Learn to interpret visual presentation of the equipment in terms of quantities of fish and species composition of the schools. This will be accomplished by scanning commercial haul areas before seine-hauls are made, and comparing the actual catch of the seine with the prediction made from the equipment. 4. If and when results can be predicted with a high degree of reliability, a promotional program will be undertaken to establish this equipment in the industry. It will be demonstrated to all of the commercial seiners who may be in a financial position to afford this kind of refinement. It is expected that the first summer will be involved with the selection, acquisition and adaptation of the gear. The first winter will be involved with learning to use it and interpret the read-out. Further experimentation with gear and methods and promotional or extension work should occupy the second winter.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Minnesota State Government

8.0139, DEPTH CONTROLLED STREAMER DEVELOPMENT

R.A. BRODING, Seismograph Service Corp., *Tulsa, Oklahoma*

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Seismograph Service Corporation

8.0140, DEEP-SEA CORE MAGNETOMETER AND A CORE ORIENTATION SYSTEM

D.F. HEINRICHS, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

A device will be obtained for determining the orientation of ocean sediment cores and a sensitive spinner magnetometer procurred to study direction of remanent magnetization of core material. The equipment will be assembled from commercially available parts.

SUPPORTED BY U.S. National Science Foundation

8.0141, DEEP SEA PHOTOGRAPHIC SYSTEM AND A BOX CORER

L.D. KLUM, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Support is provided to construct a box corer and to purchase a stereo camera. The camera assembly and box corer may be used as separate systems or combined into a single camera corer. A mutual need for the gear has arisen among the marine geologists and the benthic ecologists at Oregon State University, Department of Oceanography. This equipment would augment and broaden the scope of present research programs.

SUPPORTED BY U.S. National Science Foundation

8.0142, MANAGEMENT OF THE OCEAN SALMON FISHERY WITH EMPHASIS ON THE BARBLESS HOOKS AS A MANAGEMENT TOOL

R. LOEFFEL, State Fish Commission, *Portland, Oregon* 97201

The hook and line (troll) fishery for chinook and coho salmon in the ocean uses gear that will catch salmon that for reasons of size limit and season cannot be kept. However, the effects of hooking results in mortalities to fish number into the hundreds of thousands annually. Part of this mortality is due to damage done when the barbed hook employed is removed from the fish. Such loss could be avoided if a 'barbless' hook were used. The objective of the program is to measure the difference in survival of fish released from each kind of gear and to obtain information on the efficiency of barbless hooks for catching legal-sized salmon. Further information on salmon origin and migration will also be obtained. The work will be done along the north Oregon coast. Barbless and barbed hooks will be fished in paired fashion. Data on hook efficiency will be collected immediately. Survival information will be gleaned from the returns of tagged fish. Field work will commence in April 1967 and continue through June 1967. A second year of field work is anticipated. Project conclusion will be in 1970.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Oregon State Government

8.0143, PRELIMINARY TESTING OF PELAGIC TRAWLS ON SMALL DRAGGERS

R.W. BURTON, State Dept. of Nat. Resources, *Providence, Rhode Island*

Initial testing of available trawls is necessary to determine the type of trawl best suited for small draggers and to learn the most efficient and effective methods of handling the gear. It is also more economical to eliminate one trawl appearing less efficient or more difficult to handle, concentrating on two appearing to be best.1. A 220 HP vessel will test: the Boris trawl(British), Herman Engel trawl (German), and a Cobb trawl (American). 2. A 350 HP vessel will test: the Boris trawl, Herman Engle trawl, and the Cobb trawl. 3. Operating characteristics will be measured and recorded, including (but not limited to) the following: a. Opening at mouth of trawl: height and width, determined by transducers on headrope and trawl doors. b. Speed of towing (constant tide or current) during given rpm over a measured course. c. Characteristics of handling, operating gear, including ease and accuracy of depth adjustment.

Part 1 of 2.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Rhode Island State Government

8.0144, OPERATIONAL TESTING OF THE PELAGIC TRAWLS ON SMALL DRAGGERS

R.W. BURTON, State Dept. of Nat. Resources, *Providence, Rhode Island*

Detailed testing of the two best trawls, determined during Sub- Project 1 will be conducted to determine efficiency and feasibility of each for small dragged trawl performance, ease of handling and other characteristics will be recorded and evaluated. 1. Two 220 HP vessels will be used to fish the same grounds, exchanging trawls to minimize effect of vessel and personal ability of captain and crew. (a) Operating characteristics will be measured and recorded, including (but not limited to) the following: (1) Opening at mouth of trawl: height and width, determined by use of transducers on headrope and trawl doors. (2) Speed of towing (at constant tide or current) during given rpm over measured course. (3) Characteristics of handling, operating gear, including ease and accuracy of depth adjustment. (4) Catch characteristics of each trawl: a. total catch per unit of effort (time). b. Composition and value of total daily catch. c. Comparison of pelagic trawl catch with conventional otter trawl fishing in same area, including total weight, composition and value of catch, comparison of effort (dragging time, net size, horsepower, etc.). 2. Two 350 HP vessesl will be used to fish the same grounds, exchanging trawls to minimize effect of vessel and personal ability of captain and crew. Same as in 1 above.

Location: Point Judith Fishermen's Cooperative, Inc., Point Judith, R. I. adjacent waters.

Part 2 of 2.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Rhode Island State Government

8.0145, LOW NOISE MULTI-CHANNEL HYDROPHONE CABLE

C. BERGLUND, Teledyne Incorporated, *Houston, Texas* 77036

Design, construct and test a radical innovation in hydrophone cable construction for towing astern of a seismic profiling ship. In addition to depth and tension control, the low-noise specification requires physical isolation of the hydrophones from the major stress members of the cable. A 24-channel objective is specified with cable lengths exceeding 7500 feet.

SUPPORTED BY Teledyne Exploration Company

8.0146, LOOK-OUT ASSIST DEVICE

UNKNOWN, Sperry Rand Corporation, *Charlottesville, Virginia*

Purpose: To develop a Look-Out Assist Device which automatically and effectively warns the bridge watch of traffic hazards at night and in fog.

Description: Prototype equipment to provide 'see', 'hear', and 'talk' capability that will indicate proximity of other ships in poor visibility is being developed. The techniques used embody simple low cost radar that can see objects passing through two range rings, each one mile deep, gives an alarm and indicates the approximate bearing of such objects; a sensitive microphone array to hear sounds of whistles, bells, fog horns, etc., and indicate their bearing; and a system that records the sounds for playback identification, and will alert the conning officer of targets by a series of prerecorded announced statements, such as 'Mr. Mate, you have an object off your port bow'.

The composite device is being evaluated on the Great Lakes ship SS WILLIAM GREENE of the Cleveland-Cliffs Iron Company. It is anticipated that detection from this device will provide more reliable and accurate information to the navigation officer than can now be obtained by visual means.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

8.0147, AN INVESTIGATION OF THE EQUIVALENT FIXED INTENSITY OF FLASHING LIGHT STIMULI

J.T. MONTONYE, Univ. of Virginia, Graduate School, *Charlottesville, Virginia* 22903

This work seeks measurement of the equivalent fixed intensities of incandescent flashing lights of various flash duration. Haploscopic cotermination brightness matching and/or magnitude estimation techniques will be used. With the former technique, a succession of reference flash lengths may be necessary at each supra-threshold level until a steady source is approximated.

The Coast Guard is primarily interested in a quantitative determination of the equivalent fixed intensities of flashing lights as a function of their intensity time distribution for each of the following observer conditions: When the equivalent fixed light illumination at the observer is 0.2, 2 or 20 microlux, then the Background Brightness is 0.1, 1.5, or 31 nits respectively. From this information, the validity of the Blondel-Rey absolute threshold relation for use at these levels will be studied.

The Coast Guard is secondarily interested in a quantitative determination of the supra-threshold advantages to be gained through the use of signal light flash lengths in the Broca-Sulzer region. Thirdly, it is interested in the variation of the equivalent fixed intensity of a signal light as a function of the supra-threshold level at which it is observed.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

8.0148, TAG DETECTION

E.D. JEWELL, State Dept. of Fisheries, *Olympia, Washington*

Project staff will acquire tag detection equipment, using the same to detect tags in the Puget Sound coho fishery where fish with previously applied color coded, magnetic wire tags will be caught and landed. These field tests will reveal a range of short comings of the equipment as now constructed, as relates to the variety of conditions under which it will need to operate in order to be most useful in furthering fisheries research and management objectives. Equipment will undergo continual and necessary adjustments and adaptations of technique as experience in its use may direct. Several detectors and spares will be available for use at one time, to provide broadest coverage during the limited season when tagged fish will be present in the fishery for testing. Tests will be centered chiefly on coho in the Hood Canal and Admiralty Inlet areas, where tagged fish will occur in greatest density by reason of proximity to their home streams. Tests will cover the commercial coho fishery, as well as sports caught coho, and finally home streams of release at spawning time. The period for coverage of the commercial net catch will be restricted to the September-November fishing season as prescribed by law. The sports catch will be examined through the period when significant numbers of coho occur in this fishery. Stream coverage will extend from November through December.

Support vessels required for contacting the fishing fleet on the grounds will be supplied by the Department of Fisheries.

Part 1 of 2.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

8.0149, TAG EXTRACTION

E.D. JEWELL, State Dept. of Fisheries, *Olympia, Washington*

Under this phase effort will be directed toward: (1) removal of portions of the head of coho salmon, detected as having been tagged, and the final removal and identification of the tag, (2) develop a tool and associated techniques for removing head portions with a minimum but acceptable level of damage to either the market value of the fish, or its trophy value if sports caught.

Further work under this phase will involve personnel training in the complete extraction, identification and recording of tags recovered. These procedures are presently in their infancy and will require considerable refinement as part of the total program of coded wire tag development, directed toward a full realization of the potential of the device. The laboratory site utilized for tag recovery work will be selected later. In addition to tag removal and identification, coming from Sub-project 1, prior training of tag removal personnel (June-August) will occur with the use of fish collected during 1965, and now in frozen storage at the Department's Minter Creek Hatchery. Prior training on stored fish, under the supervision of the project leader, will expedite tag removal during the season when fresh fish and fresh tissue will arrive, allowing also for concentrated efforts by other personnel on problems of field detection.

Part 2 of 2

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

8.0150, UPGRADING CONVENTIONAL FISHING TECHNIQUES

D.L. ALVERSON, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Seattle, Washington* 98102

A study of conventional methods of capturing marine animals is being conducted in an effort to apply the benefits of modern industrial technology to the commercial fishing industry of the Pacific Northwest.

Principal experiments include the application of electronics, instrumentation, telemetry, hydraulics, echo ranging, echo sounding, streamlining techniques, more efficient deck layout, modern shipboard machinery, improved geometry of fish nets, better ratio of horsepower to gear size, safety, and synthetic materials.

Initial experiments are concerned with determining the effectiveness of midwater trawling and its possible application in the commercial fisheries. As part of the midwater trawling investigations, experiments are also conducted utilizing electrical towing cables and remote instrumentation such as depth and temperature telemetry, catch indicators, bottom contact indicators, load indicators, underwater lighting, high frequency echo sounding, electrical shocking gear and remote actuation devices.

Improvements in the geometric configuration and general performance of midwater trawls are attempted through the use of sea sled mounted scuba divers who observe the gear in action and made recommendations for design changes. Current investigations involve use of internal fykes, intermediate and cod end liners, maximum efficiency of webbing, incremental hang-in techniques for better load distribution, and determination of minimal speed requirements.

Work schedules in the near future include: automation of trolling vessels, near bottom trawling over rough round, and deepwater demersal fish traps.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0151, DEVELOPMENT OF NEW FISHING TECHNIQUES

D.L. ALVERSON, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Seattle, Washington* 98102

Utilizing modern methods of underwater observations such as SCUBA, television, still and motion photography, and electronic and acoustic telemetry, information is collected on the behavior of fishes, performance characteristics of fishing gear, effect of bottom topography on active fishing gears, and other factors influencing the capture of marine animals.

Data is collected on the physical factors involved in the various parameters of fishing gear performance such as load shock, shear, stress, vibration, speed, drag and pressure.

Experiments are conducted utilizing light, sound, electricity and chemicals to determine their effectiveness in facilitating the capture of marine animals.

Information thus gained is used in the design, construction, test, and evaluation of experimental devices and methods which might be used by commercial fishermen to capture marine animals.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0152, OCEAN ENGINEERING

R.L. MCNEELY, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Seattle, Washington* 98102

The objective of this program is to upgrade commercial fishing techniques by incorporating modern engineering technology into new gear designs and methods.

Experiments will be conducted with a special polyurethane coating for nylon netting to reduce chafing during fishing operations.

Improvements will be made to an electrical depth telemetry system. A digital readout to improve accuracy and improved underwater connectors to improve reliability will be tested.

Electronic devices to monitor vertical and horizontal mouth opening and strains that develop in the trawl during fishing operations will be tested. Nylon rope with stretchable electrical conductors will be use to monitor devices placed on the trawl.

An electrical shocking system for improving the catching efficiency of trawls is being examined.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0153, FISHING GEAR RESEARCH AND DEVELOPMENT

R.L. MCNEELY, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Seattle, Washington* 98102

The objective of this program is to upgrade commercial fishing techniques by improving existing fishing methods and developing new gear designs.

Seminar for fishermen will be scheduled. New gear, construction techniques and handling methods will be presented and discussed. This will be supplemented with still and motion picture photography of operational fishing gear.

Tests and modification to the Universal trawl will be continued. The objective is to design a commercially acceptable trawl that can be fished at any level in the water column.

Design and construction of a trawl net to incorporate a third towing warp operated from the trawl net reel will be completed. Sea trials are scheduled for late FY 1969.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0154, UNDERWATER CAMERA SYSTEM

L.C. BENNETT, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The purpose of the purchase of an underwater camera system is to replace a system lost during a recent oceanographic cruise. This camera system will permit the continuation of investigations in the Northeast Pacific Ocean and regional inshore waters, and will provide invaluable photographs of bottom sediments and structures to supplement data obtained by other geological and geophysical methods.

SUPPORTED BY U.S. National Science Foundation

8H. POWER SYSTEMS

(boilers, Nuclear Power Sources, Fuel Cells)

8.0155, INVESTIGATION OF NUCLEAR THERMIONIC POWER FOR MARINE APPLICATIONS

J.E. GINGRICH, General Electric Company, *Pleasanton, California*

This project is investigating the application of nuclear thermionic power to the marine environment.

The utilization of nuclear reactors which can generate electricity directly is of interest to marine systems because of several attractive features; namely, compactness, long life, silence, reliability, etc. Major research programs are currently underway in this country and abroad to develop components for thermionic reactors which are intended primarily for space applications. While much of this technology is directly applicable to marine systems, there are also major differences that must be considered. This project is utilizing the results from other thermionic reactor R & D Programs and applying it to systems for the marine environment. The work is being accomplished primarily through the formulation of preliminary designs for thermionic reactors suitable for undersea power uses.

This work began in 1961 and will be continued indefinitely in pace with other thermionic power development programs.

SUPPORTED BY General Electric Company

8.0156, POWER SOURCES

UNKNOWN, U.S. Navy, Civil Engineering Lab., *Port Hueneme - Point Mugu, California*

Objective: Adapt electronic power sources to ocean bottom and subbottom installations. Installations on or in the ocean floor will require electric power to perform missions and for station support. Power sources which are available for ocean application are conventional, nuclear reactor, isotope generator and storage battery. These sources with the exception of conventional can be either in-situ, surface tendered or shore based. However, each of these sources will require that their systems characteristics be matched to the operational requirements of the installation. Associated problems such as safety, waste heat removal, power transmission, and incompatability of equipment to size of pressure hull exist and must be solved before placement of the power source can be completed. Information on submarine cables is available for use in power transmission systems, however, suitable power connectors have not been developed. The goal which will be achieved under this task area will be to develop the technology (excluding the development of power source) to adapt power sources in ocean areas.

Approach: Achievement of the objective involves work in the following areas: Area 1: Develop the safety criteria for use with ocean power sources. Results of current studies will indicate problem areas in safety design which must be solved. Area 2: Develop power connectors for use in power transmission systems for ocean installations down to 8000 feet. These power connectors will have to be compatible with existing submarine cables. Area 3: Investigate the problems encountered in incompativility of equipment size to pressure hull feasibility in emplacement of large power sources down to 6000 feet. Area 4: Develop criteria to solve the waste heat problems encountered in placing power source in-situ.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0157, HYDROGEN PROPERTIES

R.J. CORRUCCINI, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Boulder, Colorado*

Measurements of the refractive index of fluid hydrogen and the dielectric constant of solid hydrogen have been completed. They have been analyzed in terms of the density and temperature dependence of the Lorentz-Lorenz functions and the Clausius-Mossotti function. The results find application in the densitometry of fluid and slush hydrogen by the aerospace industry. Their scientific value lies in providing new information on the interactions between molecules.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0158, UNDERSEA PROPULSION AND POWER SOURCES

J.W. MURRIN, U.S. Navy, Ordnance Systems Command, *Washington, District of Columbia*

Objective: Develop power sources for application to undersea propulsion. These sources, either as chemical heat generators or as electrical energy generators must provide power at rates significantly exceeding those of present sources.

Approach: The combustion of some metals or inorganic materials specific energies far greater than the combustion of the usual organic fuels. To develop superior high energy-density batteries electrolytic systems based on liquids other than water are being explored.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0159, PROPULSION FOR SWIMMER VEHICLES

F.J. ROMANO, U.S. Navy, Ship Systems Command, *Washington, District of Columbia* 20360

Objective: To establish and demonstrate feasibility of closed cycle power systems for use in swimmer delivery vehicles (SDV).

The power system under investigation includes a closed exhaust heat engine, utilizing chemical fuels which will provide mechanical power for SDV propulsion, electrical power for vehicle electronic equipment, and heat energy for swimmer heating.

Approach: A contract was let to industry to establish state-of- the-art of the thermochemical power fueld and to establish the optimum type closed cycle power system to meet specific SDV propulsion requirements. Based on the results of this study an experimental model of the closed cycle propulsion system, as recommended by the study, will be developed. Development of the experimental model of the system will demonstrate feasibility of the closed cycle concept and will provide the design parameters and operating characteristics necessary for development of a developmental system.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0160, HYDROGEN-OXYGEN FUEL CELLS

B.B. ROSENBAUM, U.S. Navy, Ship Systems Command, *Washington, District of Columbia* 20360

Objective: Develop laboratory breadboard modules of fuel cells operating on hydrogen (H2) and liquid oxygen (LOX) for ultimate encapsulated advanced development of a family of 5 to 30 KW systems for undersea operation. Operational aims: power density (exclusive of fuel and oxidant), 50 lbs per KW; operating life, 5000 hrs (before 30% loss in power); electrode precious metal load, 20 GM per KW (max). Directed to use for both continental shelf (gaseous H2 and LOX) and deep submergence (liquid H2 and LOX) levels. Ancillary objectives include: generation of hydrogen from logistically feasible fuels (EG, JP5, methanol) for shallow operation: delivery and safe handling of liquid H2 and LOX for deep submergence. Power plants of this type will permit a ten-fold increase in energy capability over secondary battery systems.

Approach: Development and evaluation through industry and Navy labs of a 5 KW cryogenic H2-02 fuel cell module designed, from the standpoint of heat rejection and purge gas handling; for encapsulation and testing under simulated ocean environment conditions. This approach will be closely integrated with a NASA procurement for a 5 KW encapsulated system to be operated in an outer space environment. Evaluation of latest state-of-the-art 2.5 KW circulating electrolyte H2-02 fuel cell module under submarine attitude conditions (pitch, roll, yaw, ascent, descent). Development of hydrogen generators operating on JP 5 or methanol for use in conjunction with 10 to 30 KW fuel cell system. Establishment of safe method of delivering and handling cryogens (H2 and 02) for deep submergence fuel cell use. Solution of problems of voltage regulation, off-design performance, etc., fuel cells.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0161, COLLATION OF POWER PLANT STUDIES

UNKNOWN, Illinois Institute of Technol. , Graduate School, *Chicago, Illinois* 60616

The five power plant studies sponsored by the Maritime Administration during the period 1961 through 1964 dealing with the design of economical integrated power plants for the propulsion of future American merchant ships were reviewed and combined.

The initial studies, which included two steam power plants, two gas turbines, and a diesel engine, were as follows: Allis-Chalmers Mfg. Co., ‘Integrated Marine Stream Turbine Propulsion Plant‘; Newport News Shipbuilding and Dry Dock Co., ‘Integrated Steam Power Plant‘; General Electric Co., ‘Integrated Gas Turbine Power Plant Design Study‘; Pratt and Whitney Aircraft Division of United Aircraft Corp., ‘Integrated Marine Gas Turbine Powerplant‘; and Fairbanks-Morse Power System Division of Colt Industries, ‘Fairbanks-Morse Advanced Design Motor Ship Machinery Plant 20,000 SHP‘.

IITRI extracted sufficient information from the above reports to permit a direct technical and economic comparison of the five power plants, with the information condensed into one concise volume. The report gives brief descriptions of the plants and their auxiliary systems, and compares the economic factors on a common basis with respect to estimated initial costs and operating costs.

The study concludes that the diesel powered ship seems to be the most economical, and steam powered vessels have an economic advantage over those powered by gas turbines. It also concluded that with anticipated improvement in construction materials the gas turbine power plants will show greater promise.

The report PB No. 175-612 is available from the Federal Clearinghouse for Scientific and Technical Information, Springfield, Virginia, 22151.

8. ENGINEERING AND TECHNOLOGY

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0162, THERMO-ELECTRIC GENERATORS

A.B. NEILD, U.S. Navy, Marine Engineering Lab. , *Annapolis, Maryland* 21402

The work under this task is to complete the evaluation of a thermo- electric generator developed for use in the ONR/Convair oceanographic buoy. Bench tests will be completed, causes of observed failures will be studied, test installation will be disassembled and a final report submitted.

This effort was undertaken to produce a highly reliable electric power source for unattended operation at sea. The results will be beneficial to buoy development programs and to other similar requirements of the Navy's operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0163, LOADING CHARACTERISTICS OF A CHARGE-CONSTRAINED SYNCHRONOUS GENERATOR

J.P. REGAN, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

Previous electric-field-type electromechanical energy converters have relied on a variable capacitance, with terminal voltage constrained. An electrostatic generator is studied which employs a spatially varying charge distribution with the potential unconstrained. Energy is converted from mechanical to electrical form by means of a synchronous interaction between the excitation charge wave on the moving medium and the fixed load. Power output characteristics for both a continuum and discrete loading arrangements are derived and analyzed. A study of the effects of discrete loading is essential to understanding operation with a finite number of phases.

It is shown that such generators may be modeled by an equivalent circuit containing a current source in parallel with a characteristic internal capacitance and a load impedance. The values of these circuit elements are determined by the excitation charge wave and geometrical factors such as: load-to-charge wave spacing, charge-to-ground potential distance, and interelectrode spacing and number of phases in the discrete loading case.

For the discretely loaded generator, the output theory is derived by assuming the form of the potential distribution along the loading electrodes. The discreteness requires that Fourier techniques be used and that the distribution be treated as an infinite sum of spatial harmonics of the fundamental wavenumber of the exciting charge wave. A six-phase, discretely loaded generator with an electrode-to interelectrode width ratio equal to 1.54 is analyzed in detail. It is shown that this generator can deliver 75% of the power available from a continuously loaded generator having the same excitation and physical parameters. Data are presented to predict output power for discrete loadings, with the number of phases varying from five to 42. A six-phase laboratory generator is used to determine the equivalent circuit element values.

The theory predicts the current source magnitude to within 6%. With the stray capacitance due to electrode structure quantified included, the characteristic internal capacitance is predicted to within 5% by the theory.

SUPPORTED BY Massachusetts Institute of Technology

8.0164, AUTOMATIC BOILER CONTROLS

UNKNOWN, Cleveland Cliffs Iron Co. , *Cleveland, Ohio*

Purpose: To install, test and evaluate an automatic marine boiler control system capable of safe and economic operation without human manipulation over the entire range of ship operations.

Description: The system provides automatic start-up, purging restarting, and operation of feedwater, fuel, and air control for a marine boiler to enable it to respond to turbine throttle steam demands for maneuvering and steady ship operations. As installed on a single boiler ship in Great Lakes service, the control operation is continuous from spring start-up until winter shutdown.

The Steamer WILLIAM G. MATHER is currently in its fifth operating season with these automatic boiler controls installed. The controls have required only normal routine maintenance and, once the system was debugged, no operating casualties have occurred.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0165, HIGH-POWER HYDROACOUSTIC VIBRATOR DEVELOPMENT

R.A. BRODING, Seismograph Service Corp. , *Tulsa, Oklahoma*

Summary: Previous hydroacoustic vibrators for marine 'VIBROSEIS' operation were power limited to approximately 94 db ref. 1 yard. An improved vibrator was evolved that was capable of 104 db output over a greater frequency spectrum. This vibrator made use of a hydraulic power source of over twice the power output in a prime mover, a hydraulic pump of twice the flow capability and a servo control value of over six times the flow capability. The vibrator proper makes use of a four foot diameter water piston compared to a 30-inch piston previously used. The ram area and stroke were also increased to give essentially a full power capability from 10 to 120 Hz. Extensive testing of this vibrator has verified its power capability and reliability under extended operations with the vibrator under tow at 6 knots and at depths of 35-40 feet.

SUPPORTED BY Seismograph Service Corporation

8.0166, AN IMPROVED MARINE VIBROSEOS INSTALLATION

R.A. BRODING, Seismograph Service Corp. , *Tulsa, Oklahoma*

Summary: Four high-powered hydroacoustic sources with four power units, hoists, hydraulic tow lines and tow arms were installed on the Motor Vessel King Tide. The 703 computer controlled data acquisition system was also installed, along with a 1 or 1-1/2 mile 24-channel streamer cable, streamer depth depressors and storage reel for the streamer. The system was designed for continuous tow at 6 knots with the vibrators and streamer depressed at 30-40 foot depth. In a typical working day 50 miles of data are collected. If navigation control permits, this coverage can be doubled with a second shift. Redundancy in equipment as well as alternate modes of operation permit little loss of time in case of any failures in the system. The greatest deterrent is the limitation in working in seas of not greater than sea state 4 due to noise on the cable and ability to work on deck.

SUPPORTED BY Seismograph Service Corporation

8.0167, MERCHANT SHIP REACTOR PRELIMINARY SAFETY ANALYSIS

UNKNOWN, Westinghouse Electric Corp. , *Pittsburgh, Pennsylvania*

Purpose: To prepare a Preliminary Safety Analysis of the proposed Westinghouse Maritime Reactor Plant installed in a merchant ship to determine acceptability of the design from a safety viewpoint, and necessity for further related research and development work.

Description: The government and Westinghouse jointly funded for the preprartion of a Preliminary Safety Analysis of the advanced Westinghouse maritime reactor design, installed in a representative ship. The special design safety features include omission of the secondary reactor space containment, and containment vessel blowdown to the innerbottom in case of primary system rupture. Compared to the SAVANNAH, the reactor features higher power density, smaller containment vessel with much higher design pressure, close coupled primary coolant system components, and a five year core requiring soluble neutron poison in the coolant at beginning of core life as well as burnable poison in the fuel.

The Safety analysis will be furnished to the Atomic Energy Commission for their review.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0168, A PILOT PLANT STUDY OF LOW EXCESS AIR COMBUSTION - ITS EFFECT ON FIRESIDE PROBLEMS IN OIL FIRED BOILERS

UNKNOWN, Babcock & Wilcox Co. , *Lynchburg, Virginia* 24505

High temperature ash deposition and fireside corrosion are considered the principle causes of decreased efficiency and availability of boilers, and often result in increased maintenance and repair costs. These problems are associated with increasing amounts of impurities, such as vanadium, sodium, and sulfur, which are present in the low cost residual oil that is used for marine fuel.

The report covers a review and technical evaluation of the information available on fuel oil combustion and allied fields to determine what benefits can be expected by operating marine boilers with controlled, low excess air combustion, and how such a combustion process can be designed and controlled. It also presents the results obtained from a pilot plant investigation of the effect of low excess air operation on the fireside problems in oil-fired boilers.

Among the significant conclusions reached as a result of this test program were the following: Low excess air combustion of residual fuels that contain sulfur is an effective method for controlling low temperature corrosion caused by condensed fuel trioxide. Much of the beneficial effect of low excess air combustion is lost if excess air at the burner fluctuates even for short periods of time to a level of about 5%. It appears that condensed SO3 from the flue gases is the primary if not the sole cause of low temperature corrosion when firing residual oils containing sulfur. Low melting compounds associated with oil-ash deposition problems when operating with normal excess air are not formed in large amounts when operating with low excess air combustion. Deposits from normal excess air tests are about twice as dense as those formed during low excess air combustion. The report PB No. 175-805 is available from the Federal Clearinghouse for Scientific and Technical Information, Springfield, Virginia, 22151.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8I. HYDRODYNAMICS

(*see Chapter 2 on Water Motion*)

8.0169, PRELIMINARY STUDIES TO CORRELATE SELECTED MINERALOGIC AND GEOLOGIC PROPERTIES WITH ENGINEERING PROPERTIES

H.D. HESS, U.S. Dept. of Interior, Marine Min. Technol. Ctr. , *Belvedere - Tiburon, California* 94920

The practicality of a shipboard mineral identification and analysis laboratory for on-site placer deposit characterization and relation of generated physical/chemical data to drill performance and shipboard sample processing operations was clearly demonstrated during the 1967 Alaska field operations off Nome. During the two months on station, approximately 1200 mineralogic, petrologic, and qualitative chemical examinations were performed utilizing spectroscopic, mercury detection, ultra-violet, radiometric, and other laboratory equipment, including stereo and polarizing-petrographic microscopes. In short, the shipboard laboratory was demonstrated to have the same functional capability as similarly equipped laboratories on shore. Also, during the Alaska operations, original investigations were conducted on geochemical trace element correlations and development of an in situ pH/temperature measuring device.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0170, HYDRODYNAMIC FLOW FIELD STUDY

J.R. RADBILL, North Amer. Rockwell Corp. , *Long Beach, California* 90803

Ocean Systems Operations adapted a computer program to calculate the flow and the associated pressure, viscous and wave drag, about advanced vehicle designs and stationery structures. The computer program (written for the IBM 360) calculated the inviscid flow field about a sumerged body of arbitrary shape. It incorporated smoothing procedures which rendered computed flow velocities insensitive to small perturbations in the body coordinates. Computed velocities were compared with analytical results for an ellipsoid to asses the accuracy of the program. Computer programs were constructed for use in the study and design of subsurface manned and unmanned systems. The computer programs can calculate flow fields and dynamic coefficients for hulls of very general shape.

SUPPORTED BY North American Rockwell Corporation

8.0171, PARTIAL DIFFERENTIAL EQUATIONS AND CONTINUUM MECHANICS

G.B. WHITHAM, Calif. Inst. of Technology, Graduate School, *Pasadena, California* 91109

Research will be continued in the areas of continuum mechanics, partial differential equations, and related topics. Whitam will continue research on non-linear wave propagation using variational principles and perturbation methods. Work will be continued on the behavior of long water waves, applying analytic and numerical methods to integro-differential equations which include effects more general then those of the usual theory. Study of the non-linear boundary value problem whose differential equation is Lu equals lambda f (x,u), where L is a Sturm-Liouville operator, f is monotone increasing in u with f(x,Phi) is not equal to phi) and the interval is finite. The stable solution will carry over to the case where L is uniformly elliptic.

Certain linear boundary value problems for partial differential equations will be considered. By making use of the spectral representations associated with the ordinary differential system arising from separation of variables, alternative representations of the solution of the original problem can be found. This technique will be used to investigate the formation of underwater acoustic wave guides when the velocity profile is not a constant function of ocean depth.

SUPPORTED BY U.S. National Science Foundation

8.0172, STUDY OF FISH MUCUS BIOCHEMISTRY

J.W. HOYT, U.S. Navy, Ordnance Test Station, *Pasadena, California*

The investigator will study the mucuses produced by fishes to determine their chemical and physical properties and to determine how they operate to reduce frictional resistance in the water and to damp turbulence. These mucal secretions will then be compared for drag reduction efficiency. The demonstration of turbulence damping and friction reducing properties of linear, high molecular weight soluble polymers is a recent development in fluid mechanics and is not yet completely understood. Visolelastic effects are probably involved and will be studied.

Locomotory mechanisms of animals in the sea are of interest on several counts. Most directly, it relates to the design of vehicles and equipment where speed or water resistance is important. The acoustics of movement is an area for study and one in which biological mechanisms may provide guidance. In addition, surface coverings of fishes may affect the echo characteristics of fishes and may serve as a stimulus to other animals which may be attracted or repelled by it. Such information could lead to knowledge about animal behavior, including pest repellents.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0173, REALISTIC FREE SURFACE BOUNDARY CONDITIONS IN NUMERICAL HYDRODYNAMICS COMPUTATIONS

F. MACINTYRE, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

It is proposed to develop a general code for including realistic free-surface boundary conditions in numerical hydrodynamics. The programming necessary to produce such a code falls into three parts: (1) Orientation. The location, curvature, and orientation of the free surface must be sensed. The surface configuration may be approximated by a series of circular arcs passing through adjacent triples of points in the surface. (2) Surface metric. In general, in the surface coordinate system best suited to a given problem will not match the coordinate system chosen for the bulk liquid. Thus, in a study of linear capillary waves on an otherwise flat surface, it is logical to cast the bulk liquid into Cartesian coordinates, yet the surface of the waves is best approximated by series of cylindrical segments. Similarly, in a study of an axisymmetric problem such as a breaking bubble, the bulk fluid wants cylindrical coordinates, but the surface itself is composed of toroidal segments. Aris 5 gives the fundamental tensorial hydrodynamic equations connecting a Riemannian surface to a Euclidean bulk fluid, complete with surface tension and the two surface viscosities. (3) Coupling. A prominent feature of the proposed approach is that the curved surface does not lie on the rectangular computation grid, so that it is necessary to treat the resulting odd-shaped grid-segments in a special manner.

SUPPORTED BY U.S. National Science Foundation

8.0174, OXYGEN PROPERTIES

R.D. GOODWIN, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Boulder, Colorado*

Objective is to determine the equation-of-state and specific heat of liquid and gaseous oxygen and to calculated derived thermofunctions. Applications are to the use of liquid oxygen as a rocket propellant oxidizer. Work falls under data on the Properties of Matter.

Measurements of the specific heat of saturated liquid oxygen have been completed. Measurements of the specific heat at constant density on fluid oxgyen are about 80% complete. The specific heat and density measurements are being checked for internal consistency. Methods have been developed for computing the derived thermodynamic functions. Applications are to the use of liquid oxygen as a rocket propellant oxidizer. The measurements provide new and/or more accurate properties data which are useful in designing more officient missile propulsion systems.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0175, WAVE ACTION ON STRUCTURES

T. SAVILLE, U.S. Army, Coastal Engin. Res. Center, *Washington, District of Columbia* 20016

The action of all types of waves on various types of structures will be studied in the laboratory using experimental models, in the field making prototype measurements, and by analytic theoretical approach. In particular such things as wave run-up, wave overtopping, wave forces, and structure stability are planned for investigation.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0176, FLUID MECHANICS RESEARCH

G. KULIN, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

To conduct exploratory investigations into problems such as (1) Hydrodynamic effects of hydrophobic surfaces; (2) Effect of turbulence on damping of progressive water waves; and (3) Effect of compliant walls on turbulent shear flows. Problem (3) is related to drag reduction, which is a matter of considerable economic and technical potential. Problem (1) has important applications in industrial processes and in hydraulic model studies, while problem (2) is related to wave forecasting. This project continues NBS work on the development and application of various measurement techniques to the solution of important hydrodynamic problems.

All of these investigations are primarily experimental. In problem (1) wettable and non-wettable plates are oscillated vertically through an air-liquid interface and the damping was observed. In problem (2) measurements were made on heights of waves propagating through water made turbulent by a series of upward-directed water jets. In problem (3) the pressure drop was measured for turbulent flow of water and water-glycerol mixtures through tubes having compliant (soft rubber) walls. Experiments have been completed for all problems.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0177, HYDRAULIC BULLETIN

G. KULIN, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

To collect information on current research projects in hydraulics, conducted at about 175 Federal, State and private laboratories in the United States and Canada; and to make these project summaries available in useful form to the scientific and engineering community. A similar publication, compiled by the International Association for Hydraulic Research (Delft, Netherlands) covers hydraulic research in all countries other than the United States and Canada. The NBS publication thus forms part of a team which provides world-wide coverage of current hydraulic research.

Through 1966, research summaries were annually solicited from appropriate laboratories and their contributions were edited and placed in a format suitable for publication. However, publication is now biennial, and the 1967 issue was omitted, with the next issue to appear in 1968.

Reporting interval - January 1 to December 31, 1967.

The 1967 'Hydraulic Research in the United States' was omitted primarily to allow time to review a potential duplication problem existing with respect to the new 'Water Resources Research Catelog' (Office of Water Resources Research, U. S. Department of the Interior). A detailed comparison of the most recent issues of each publication was made, and it was found that slightly less than 20 percent of the projects listed by NBS were also reported in the 'Water Resources Research Catalog.' This result suggested a continued need for publication devoted solely to hydraulic research. A decision was therefore made to proceed with a 1968 issue and continue biennially thereafter, while taking positive steps to minimize duplication.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0178, FLUID DYNAMICS CENTER

R.L. PFEFFER, Florida State University, Graduate School, *Tallahassee, Florida* 32306

A new university center in Geophysical Fluid Dynamics involving advanced graduate training and research in applied mathematics, continuum mechanics, fluid dynamics, meteorology and oceanography is to be initiated. Anticipated research activites include (a) laboratory simulation of the formation of offshore shoals and the transformation of shorelines, (b) theoretical and experimental simulation of convection and hurricane formation by latent heat release, (c) experimental and observational studies of ocean wave energy transformations, (d) cellular convection studies and interpretation of satellite photos, (e) theoretical, experimental and observational studies of the global atmospheric jet stream, (f) simulation of planetary atmospheric circulations and (g) application of applied mathematics and computer technology to hydrodynamical phenomena and solving the Navier Stokes equations of fluid dynamics.

Critical fleet requirements are not now adequately under study by the Naval scientific community. For example, optimal interpretation of satellite meteorological data is not possible nor will it be until basic processes of cloud formation are understood. Advanced techniques now under development at Florida State University will permit modelling of clouds in its entire complexity and acceleration of work in this area will lead to greater effectiveness in fleet meteorology.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0179, HYDRODYNAMIC EFFECTS OF SUBMERGED BODY

M.P. TULIN, Hydronautics Incorporated, *Laurel, Maryland*

Objective: To gain quantitative knowledge of the hydrodynamic effects generated by a submerged body.

Approach: Conduct theoretical analyses and model tank experiments to predict the hydrodynamic effects of submerged bodies, with emphasis on the micro-structure of the air-sea interface.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0180, COMPUTATION OF PERIODIC PROPELLER FORCES IN NON-UNIFORM FLOWS USING A LIFTING SURFACE MODEL

F.R. BJORKLUND, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

A computational method is presented based on theory of the lifting surface model of a propeller blade in non-uniform flow. Unsteady expressions, previously derived by Dr. Neal A Brown, are adapted to a numerical solution of the three-dimensional Biot-Savart integral equation for the vorticity distribution given the downwash boundary condition.

Since a computational method already exists for the solution using a lifting line representation of the blade, the analysis presented adds a correction to the results of that method. The correction is due to the effects of the radial and streamwise vorticity of the blade on itself. This has hereto been neglected in the lifting line model, but has been shown to be very significant, especially for the higher harmonics of the wake.

A computer program was developed and tested for correctness of results. Program listings and flow diagrams are included in the Appendices.

SUPPORTED BY Massachusetts Institute of Technology

8.0181, AN ANALYSIS OF THE RESPONSE OF CYLINDRICAL DUCTS TO INTERNAL, ZERO MEAN FLOW, AIR-CARRIED ACOUSTIC EXCITATION

W.T. ELLISON, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

Significant structural response of a cylindrical duct to an internal pure tone sound field resulting from an external pure tone source, located approximately on the duct centerline, will arise only when coincidence occurs between the natural modes of propagation of acoustic waves within the duct and the natural modes of structural vibration of the duct itself.

The coupling mechanism giving rise to such coincidence lies within an assumption of small variations of the source location from the duct centerline. This result which arose from a theoretical analysis based on a solution for the velocity potential within a semi-infinite cylinder in the presence of a non-axial incident plane wave and an equivalent modal resonator model of the cylinder undergoing principally radial vibrations in a lobar axially varying pattern was borne out by the experimental results.

SUPPORTED BY Massachusetts Institute of Technology

8.0182, MEASUREMENT OF WATER VELOCITY BY OPTICAL METHODS IN THE MIT PROPELLER TUNNEL

G.W. FANG, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

An optical system to detect and measure the flow velocity in the MIT propeller tunnel was built, based on the theory proposed by M.J. Block and J.H. Milgram in a paper to the Optical Society of America. The method involved the detection of reflected light radiation off air bubbles in the water. This radiation, after being spatially filtered by a reticle, is collected by a photomultiplier and temporally filtered by a bandpass filter. The frequency of the resultant signal is a function of the flow velocity.

Results of the investigation show a general agreement to within 3% between the velocities obtained by this method and that obtained by means of the pitot-static tube. Difficulties encountered in the investigation are enumerated, and recommendations are made for possible future investigations.

SUPPORTED BY Massachusetts Institute of Technology

8.0183, VARIABLE PRESSURE WATER TUNNEL RESEARCH

J.E. KERWIN, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

Funds from this grant will provide assistance in converting the MIT variable pressure water tunnel and in initiating a number of research problems. The MIT tunnel was originally constructed in 1938 - 39 and has not been modified since. The original design of the tunnel was to solve one type of problem - the steady-state thrust and torque of a marine propeller under various flow conditions. Since this type of experiment has now become routine, the tunnel is not very useful for thesis research in its present form. Changes to the tunnel will include the removal of the present open-jet test section and replacement with a 20 inch diameter stainless steel closed-jet section. A storage tank will be added to facilitate rapid access to the test section, modern instrumentation and controls will be installed, and quieting measures will be applied to the tunnel. After the tunnel is converted to a more useful research tool, the following research problems will be pursued; propeller performance in irregular flow fields, cavitation noise, cavity dynamics, mechanisms of cavitation inception, hydroelasticity and singing, supercavitating hydrofoils and propellers, propeller induced vibration, hydrodynamic performance of various deep-sea devices, and experimental verification of propeller design theory.

SUPPORTED BY U.S. National Science Foundation

8.0184, INVESTIGATION OF THE NON-LINEAR CHARACTERISTICS OF FLUID-SUSPENDED VEHICLES

R.J. KIESSEL, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

Using present linear theory results for a rigid simple plenum fluid-suspension system, it was possible to determine the accuracy of a non-linear model and of analog computer simulation when using small perturbation amplitudes.

By increasing the perturbation amplitudes it was possible to show that the range of validity of the linear theory solution increased as the lead time constant increased and also as the lead-to-tag time constant ratio increased.

Further increasing of the perturbation amplitude showed that the maximum allowable perturbation amplitude increased as the lead time constant increased and also as the lead-to-lag time constant ratio increased.

Increasing the perturbation amplitude beyond the range of validity of the linear theory showed that the peak dimensionless acceleration and the peak dimensionless change in vehicle-suspension-guideway clearance decreased.

SUPPORTED BY Massachusetts Institute of Technology

8.0185, EXPERIMENTAL INVESTIGATION OF VENTILATED CAVITIES

R.J. KINNEAR, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

A wedge with a 3.5 inch chord and a half-angle of 4.1 degrees is tested in the MIT Propeller Tunnel. No pulsations were observed on the cavity. Thus, the attempt to verify the theory that pulsations are possible in an infinite medium (without a free surface) is inconclusive.

Although there exists a variance in the cavitation number between theory and experiment, the data plotted show that the general shape of the curve for a 4.1 degree wedge is correct. The primary discrepancy is in the pressure recording methods.

Visual observations become difficult when ventilated cavities are generated in the test section. It takes only about 5 to 10 seconds for the air introduced into the cavity to recirculate through the tunnel.

SUPPORTED BY Massachusetts Institute of Technology

8.0186, UNSTEADY TWO-DIMENSIONAL CAVITY FLOWS

P.C. LEONE, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

A flow model for unsteady, two-dimensional cavity flows with finite cavities is established by examining the cases of finite aspect ratio foil and of a two-dimensional foil under a free surface in the limiting cases of high aspect ratio and large depth. Using the method of matched asymptotic expansions, the boundary conditions of the two- dimensional flow are determined and the perturbation pressure produced by the variations of cavity area is calculated as a function of aspect ratio or depth. The case of a flat plate foil with a natural cavity and executing harmonic oscillations of small amplitude is then considered, and within the framework of the linearized theory and unsteady perturbation potential is determined using the methods of the complex variable theory. Numerical results for life and movement coefficients are presented for a certain number of values of the cavitation index.

Experimental results for a two-dimensional foil performing simple pitching oscillations are presented. Those experiments cover a range of reduced frequencies (based on foil chord) of 0.2 to 0.95 and cavity lengths ranging from 2.5 to 7. The agreement between those experimental results and the theory seems to be fair.

SUPPORTED BY Massachusetts Institute of Technology

8.0187, DETERMINATION OF FLOW IN AN AXIAL-TO-RADIAL DIFFUSER WITH SWIRL

R.A. MAJOR, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

The parameters affecting the efficient design of axial-to-radial diffusers are discussed and a selection made of those to be investigated. A model diffuser was constructed based on the geometry of a jet impinging on a flat plate without internal vanes. Various amounts of swirl were introduced on a constant flow rate and the recovery of the diffuser for these conditions noted. The internal flow was mapped photographically and with pressure probes.

The results are given in the form of static pressure plots along the diffuser walls, velocity profiles, and calculated diffuser efficiency. The maximum efficiency of 91.7% occurred at just under the maximum swirl used, based on a calculated inlet pressure.

A detailed program for additional testing is given.

SUPPORTED BY Massachusetts Institute of Technology

8.0188, VISCO-ELASTIC DYNAMIC VIBRATION ABSORBER

G.L. MORROW, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

Objective. The objective of this thesis work was the design, construction, and instrumentation of an apparatus to determine the dynamic properties of visco-elastic fluids for application in damped dynamic vibration absorbers.

Method: The result of the design was a set of parallel plates tailored to fit a Calidyne 01500 shaker. The shaker was used to provide the driving force. The lower plate was held stationary and the upper plant constrained to move in one dimensional translation. The dynamic variables measured were the magnitude of the applied force and phase angle between force and displacement. The force was measured via a strain gauge transducer, constructed for the thesis, and phase angle was measured by a phase detector using displacement as a reference. Both force and phase were plotted automatically against frequency by an X-Y recorder. The viscosity and modulus of elasticity were then calculated from the measured quantities.

Results: The apparatus was shown to function satisfactorily and sufficient data was taken to check the performance with results obtained from the Caterpillar Tractor Company for the silicone fluid used in the test. Both sets of data were shown to be in close agreement and not to follow linear visco-elastic theory, over the range of variables of interest. Both shear modulus and viscosity were found to be functions of frequency.

Conclusions: It is the conclusion of the authors that this apparatus will perform satisfactorily for a wide range of fluids which may have damper application. The results will be improved, however, with implementation o of the recommendations below.

SUPPORTED BY Massachusetts Institute of Technology

8.0189, INVESTIGATION OF HEAT TRANSFER AUGMENTATION THROUGH USE OF INTERNALLY FINNED TUBES

W.D. SNIDER, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

Experimental data were obtained on heat transfer and pressure drop for water flowing in internally finned tubes. The test sections were steam heated copper tubes with integral internal fins ranging in size from 0.625 in. to 1.060 in. outside diameter with both straight and spiral fins. Heat-transfer coefficients and friction factors were determined for non-boiling forced convection heating.

Improvements in heat transfer for finned tubes compared to conventional tubes of the same internal diameter of up to 200 percent were found in some of the cases tested. The major portion of the improvement in heat transfer results from additional heat-transfer area added on the water side of the tube. Swirl flow was also found to contribute significantly to improved heat-transfer performance.

This investigation represents a start toward the development of a general prediction method for internally finned tubes. Further investigations are recommended to determine the effects of tightness of twist, number of fins, fin height, and fin profile on heat-transfer improvement and the value of internal fins as an augmentative technique.

SUPPORTED BY Massachusetts Institute of Technology

8.0190, HETERODYNE MEASUREMENTS OF ATMOSPHERIC PHASE TURBULENCE AT 6328A

M.A. TAMNY, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

This thesis investigates the effects of atmospheric turbulence on the spatial properties of the phase of transmitted beams. Experimental measurements in the form of a series of photographs of interference patterns between two beams were made using a modified optical heterodyne system. The two beams of the heterodyne system were mixed with a very small, controllable angular difference between their directions of approach to the detector. The resulting fringe patterns were affected by the atmosphere as differences between succeeding photographs show. The first order effect of the atmosphere was found to be a tilt relative to the direction of travel. Tilt differences as small as 5 seconds of an arc can be measured using this sytem with assurance; smaller values could be confused with systematic effects.

SUPPORTED BY Massachusetts Institute of Technology

8.0191, VORTEX WAKE SHEDDING OF A HEAVING CIRCULAR CYLINDER

R.G. WALSH, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

The periodic vortex wake shedding from a circular cylinder heaving perpendicular to the free-stream has been experimentally photographed in water using streaming air bubbles for flow visualization. The Reynolds number was greater than 10,000. The flow is a three dimensional stability problem with spanwise vortices being formed when the cylinder is stationary. For a specific range of heave amplitude and frequency, called the 'lock-in region', it is possible to have two-dimensional flow with spanwise correlation. There is an affect of free-stream turbulence and turbulence due to wake formation at high Reynolds number flow upon the 'lock-in region'. After a discussion of the past and present investigations of this flow phenonenon, it is modelled as a fluid oscillator. A discussion of the analogy between the flow and the oscillator characteristics is presented.

SUPPORTED BY Massachusetts Institute of Technology

8.0192, EXPERIMENTAL HYDRODYNAMICS

A.C. VASTANO, Woods Hole Oceanographic Inst., ***Woods Hole**, Massachusetts* 02543 (N00014-66-C0241)

This study is a continuing attempt to elucidate details of the hydrodynamics of flow regimes on a rotating earth that are pertinent to the understanding of oceanic phenomena. Part of the work is theoretical but it is supplemented by fluid dynamics laboratory studies of flow regimes in realistic models and by field measurements from ALVIN. A numerical model of western boundary currents is being developed. Laboratory experiments study the physical processes occurring at density interfaces and measure the fluxes of heat and salt through them. Small scale structure in the oceans also is to be observed with the use of ALVIN in the region of the main thermocline.

Results from this task should further the development of numerical models of physical processes in the oceans from which operational prediction methodology may be developed to meet the Navy's broad needs for environmental forecasts of the oceans.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0193, FLUIDIC CONTROL SYSTEM COMPENSATOR

C.K. TAFT, Univ. of New Hampshire, Graduate School, *Durham, New Hampshire* 03824

Fluidics is the technology wherein sensing, logic manipulation, amplification, information processing, control and/or actuation functions are performed solely by controlling fluid dynamic phenomena with fluid inputs. Fluidic devices or systems can perform theses functions using no-moving-part elements and appear to offer the advantages of reliability, low cost, and simplicity. These advantages are especially true in control strategies which utilize the unique properties of fluidic devices is being made at the University of New Hampshire.

It is the object of this research to investigate the following: 1. Periodic modulating signal waveform effects and frequency limitation on fluid components. 2. The number of delays that can be used in a compensator and their duration. 3. Fluidic switching device characteristics will affect pulse-width modulator performance. Hystersis and non zero operating time will all contribute to the effective characteristics of this portion of the system. The effects of these nonideal characteristics will be described analytically. 4. The types of compensators which can be mechanized will be classified and their design specification simplified. 5. An experimental model using fluidic elements will be used to demonstrate the feasibility of the approach and verify the design strategies developed.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0194, MODEL STUDIES OF REFRACTION OF SHOALING OCEAN WAVES

W.J. PIERSON, New York University, School of Engineering, *New York, New York* 10003 (NONR)

Objective: The laboratory wave-tank experiments on the behavior of refracted waves at caustics are to contribute to development and improvement of Navy wave forecasting methodology required to predict sea surface conditions in support of naval operations. Research on refraction effects particularly aids in the prediction of surf conditions.

Approach: A laboratory wave tank with various shaped, modeled shoals is being used to study the behavior of gravity waves at caustics produced by refraction effects as waves progress over these shoals. Emphasis is upon determining the transfer of energy at caustics.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0195, AZORES VOLCANIC STUDY

G.M. BOONE, Syracuse University, Graduate School, *Syracuse, New York* 13210 (NONR)

Investigations are made on the structure, sequence of eruptions, and chemical analyses of volcanic (basaltic) rocks that comprise the eastern part of San Miguel Island, Azores. Chemical analyses are made of the rock samples obtained during a field mapping program to determine the age of the rocks, the times of eruption, and magma depths from which the flows originated. As the Azores are along the Mid-Atlantic Ridge, this study bears on volcanic and tectonic problems associated with mid-ocean rises.

As the task concerns the volcanic and tectonic processes along one part of the Mid-Atlantic Ridge, it provides information that affects bottom topography, bottom roughness, and sedimentary layering associated with this mid-oceanic ridge.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0196, MARINE HYDRODYNAMICS

M. RATTRAY, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

It is proposed to carry out the following studies: (1) Investigate a theoretical model for the combined wind-driven and thermohaline circulation of a zonal ocean, which is expected to demonstrate the essential physics of the Antarctic Ocean circulation. Results of this investigation will lead to refined models for the Antarctic Ocean and serve also as a preliminary step in the investigation of the circulations in oceans with meridional boundaries. (2) Include the effects of friction and nonrectangular geometry in an extended theoretical model of internal wave generation. This work is based on our recent results for the internal waves generated in a continuously stratified ocean by bathymetric coupling, at a steep continental slope, to long surface waves. Laboratory experiments will be continued to test the above theoretical results. (3) Laboratory studies will be performed to investigate the generation of internal waves by free oscillations of neutrally buoyant bodies. (4) Laboratory experiments will be performed to test the range of validity of theoretical averaging techniques for the study of non-linear wave behavior. (5) Solutions will be sought for the quasigeostrophic free oscillations in a B-plane ocean that are intermediate in frequency range to those presently known. etc.

SUPPORTED BY U.S. National Science Foundation

8J. MATERIALS

(*design, Fabrication, Testing, and Environmental Effects. See Chapter 5g For Microorganisms Causing Degradation.*)

8.0197, CHEMICAL WOOD PRESERVATIVE TREATMENTS

H. HOCHMAN, U.S. Navy, Civil Engineering Lab. , *Port Hueneme - Point Mugu, California*

Objective: To improve methods and materials for the treatment of timbers to prolong resistance to marine borers in a marine environment.

Approach: A number of approaches have been used, including a study of naturally resistant woods, analysis of creosotes, development of toxicity tests and harbor screening tests. A number of treating systems are receiving final evaluation in 20-foot piles at Pearl Harbor.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0198, EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE

H.P. VIND, U.S. Navy, Civil Engineering Lab. , *Port Hueneme - Point Mugu, California*

Objective: To evaluate paraffinic waxes and other saturated hydrocarbons as agents for preventing bleeding and leaching of wood preservatives from marine timbers.

Approach: Small specimens of wood impregnated with various mixtures of creosote and paraffinic hydrocarbons are placed in sea water aquaria well stocked with marine borers of the species Limnoria tripunctata. The times required for the marine borers to sever the specimens of wood are employed as measures of the effectiveness of the preservative mixtures.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0199, CORROSION RESEARCH

P.H. BENSON, Lockheed Aircraft Corporation, *San Diego, California* 92101

Marine Corrosion and its prevention - Cathodic Protection, Electro- chemistry (COR)

SUPPORTED BY Lockheed Aircraft Corporation

8.0200, ANTIFOULING RESEARCH

P.H. BENSON, Lockheed Aircraft Corporation, *San Diego, California* 92101

Marine Biological Research - Marine Fouling and its prevention (AFR-2)

SUPPORTED BY Lockheed Aircraft Corporation

8. ENGINEERING AND TECHNOLOGY

8.0201, HELIUM - HEAT TRANSFER

V. ARP, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Boulder, Colorado*

Data on heat transport and on properties directly related to heat transport (viscosity, conductivity, and specific heat) will be produced for liquid and supercritical helium, and for superfluid helium. The systems and properties data so obtained will contribute significantly to the use of superconductors and cooled high purity conductors in industry and research, e.g., power transmission and generation systems, superconducting magnets and superconducting particle accelerators all of which must be cooled by helium.

For both Helium I and Helium II studies, compilation and critical correlation of existing data will outline specific areas of subsequent experimental measurement. For Helium I studies much of these data have not been determined and those data which do exist are not sufficiently accurate to permit optimum system design. For Helium II the parameters which correctly characterize the heat transfer of superfluid helium in large engineering systems will have first to be identified.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0202, NEW APPROACHES TO BIOFOULING ASSAY

R.J. BENOIT, General Dynamics Corporation, *Groton, Connecticut*

A. Tests indicate that a simple, quick, laboratory bio-assay procedure can be developed for use in marine fouling research. B. The evaluation of anti-fouling coatings in granular form (a new approach) appears to be feasible. C. Three test organisms were evaluated as candidates for a laboratory bio-assay procedure. D. Leaching rates obtained in granular, copper base paints was in the order of 0.1 to 0.3 mg Cu per day from 0.5 gm of powder in 100 ml sea water. The rates were consistently higher in granular paints of small particle size, and increased slightly daily for three days. These leaching rates are comparable to about 100 micrograms Cu/cm2/day and are greater than rates reported in the literature for several copper paints evaluated as coated panels.

SUPPORTED BY General Dynamics Corporation

8.0203, MICROBIAL CORROSION AND DETERIORATION OF NAVAL MATERIALS

R.R. COLWELL, Georgetown University, Graduate School, *Washington, District of Columbia* 20007

Marine bacteria are being isolated from sea water to determine whether these microorganisms differ significantly from terrestrial forms. Electron microscopy and DNA base composition as well as conventional morphological and physiological characteristics are being determined. Computer analysis of the accumulated data will be employed to identify taxonomic groups.

The effective use of the ocean as a working environment requires thorough knowledge of its microbial activities. The role of marine microorganisms in corrosion and deterioration of materials, and as disease producing agents will contribute to this knowledge. Studies of the unique physiology of true marine microorganisms will provide basic information of effective use of the sea by other biological systems.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0204, CORRELATION OF BEACH PROPERTIES AND INCIDENT WAVES

T. SAVILLE, U.S. Army, Coastal Engin. Res. Center, *Washington, District of Columbia* 20016

Study is being made, in both field and laboratory, of the relationship between beach properties (including profile as well as sediment properties) with incident wave and water level conditions. Study also involves the effect of structures in affecting changes in these characteristics.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0205, CORROSION MITIGATION

G.M. WATTS, U.S. Army, Coastal Engin. Res. Center, *Washington, District of Columbia* 20016

The investigation is to involve the collection and presentation of data showing the corrosion rate in sea water of various shapes of steel piling and of the stressing steel in pre-stressed and post stressed concrete piling. The corrosion rates are to be determined from piling installed at locations having various climatic, tidal and contamination conditions. The objective is to furnish information to aid in determining the life expectancy of steel used in piling installations.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0206, STRENGTH OF GLASS

W. CAPPS, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

Technical Objective: To develop improved methods for testing mechanical strength of glass and other brittle materials, to attempt to evaluate the influence of various types of defects on the strength of glass and to assist sponsor in developing specifications for strengthening glass for use in DSSV. (Deep Submergency Systems Vehicle).

Approach: Devise test fixtures and gather breaking strength data on commercially available and special composition glasses to modify modulus of rupture formulas to account for large deflections; to collect strength data on glass specimens containing various types and amounts of defects encountered in commercial products; to allow appraisal of the influence of the defects on the strength of the glass products, and to assist the sponsor in developing specifications for strengthened glass products for deep ocean use by means of consultation and testing.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0207, MICROBIAL CORROSION

W.P. IVERSON, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

To investigate the role of microorganisms in the corrosion of metals in a marine environment. To perform basic studies on the mechanisms of microbial corrosion in the marine environment. To relate the results of these studies to current concepts on the significance of microorganisms in causing marine corrosion.

The corrosion rates of metals and alloys in sea water, natural and microorganism free, will be compared. In cases where the corrosion rates are greater in the presence of microorganisms, isolation of the microorganisms at the corroding surface will be undertaken. The effect of such microorganism (pure or mixed culture) to again produce corrosion will be studied. Identification of organisms found to be important in causing corrosion will be done, time permitting. Isolation of and study of previously known organisms (viz. sulfate reducers) reported to have been involved with corrosion will be studied to ascertain their importance in marine corrosion and to determine their mechanism of action.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0208, STEEL PILING

M. ROMANOFF, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

Significance: To investigate the extent and causes of corrosion that occur on steel pillings in underground and marine environments and to determine the effectiveness of projective methods where corrosion is a problem. Results from this investigation are of benefit to all engineers in industry and government who are concerned with design, construction and maintenance of all types of structures using pillings.

Progress: Polarization and electrical measurements were made to determine the rate of corrosion on the pile specimens exposed in the extensive test sites at Dam Neck, Va (off-shore site) and Montreal, Quebec (underground site). Data obtained from previous inspections of steel pillings in underground service were evaluated.

Future Objectives: (1) Perform additional inspections at the offshore marine and underground test sites. (2) Evaluate data accumulated over the past 7 years at 4 test sites in Mississippi and Louisiana, in cooperation with the U.S. Corps of continued investigation of (1) isolation, growth, and nutrition of blue-green algae, especially with marine forms. (2) Further investigation of phenomenon associated with single-cell growth of coccoid and filamentous blue-greens. (3) Investigation of induced mutation in blue-green algae; effective mutagens and optimum conditions for their use, possible development of selected auxotrophic or pigment mutants for approach to specific problems.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0209, METALS FOR DEFENSE
M. ROMANOFF, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington*, *District of Columbia*

Significance - (1) To obtain information on the performance of metals and other materials in underground, marine and fresh water environments and to investigate and develop methods to provide protection to such materials when required. (2) Provide consultation services to the sponsors (Prince Project) and investigate special problems, often of an emergency nature, involving the use of metals and other materials in various environments. Priority is given to these problems over other work.

Progress - A large amount of time has been devoted to special corrosion problems of a classified nature of long and short term investigations. Goals sought by the sponsors have been achieved with considerable benefit. Work has been continued on the evaluation of specimens of monel, Cupro-Nickel, ductile iron and titanium for exposures up to 8 years at 6 underground test sites. Reports for publication on these materials are in various stages of progress.

Future Objectives - Completion of the reports for publication mentioned above. Evaluation and preparation of reports on the corrosion behavior in soils of aluminum and aluminum alloys, and stainless steels. Annual inspections to be made at 6 soil sites and 2 water sites.

Papers - Results of NBS Corrosion Investigation in Disturbed and Undisturbed soils, Proc. of 12th Annual Appalachian Underground Corrosion Short Course, West Virginia University Tech. Bull. No. 86 (1967).

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0210, MECHANICAL PROPERTIES
UNKNOWN, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington*, *District of Columbia*

Work on the mechanical properties of matter and materials includes the developemnt of methods of measurement applicable to liquids and solids under a variety of environmental conditions involving variations in method and rate of loading, the influence of temperature, pressure, etc. The work is important to extend our knowledge of the behavior of materials to cover new materials with unusual properties which characterize the material in a meaningful way, and to develop methods for evaluating the performance of important engineering combinations of materials ranging from composites of plastics and metals, to joints involving high strength aircraft fasteners, would include types required for undersea exploration vessels, to heavy built-up structural elements of buildings and bridges. Rate of change of load varies from zero for creep tests to ultrasonic frequencies. Temperatures of interest range from cryogenic nearly to the melting temperatures.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0211, EFFECT OF PRESSURE ON MATERIALS
C.E. WEIR, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington*, *District of Columbia*

To develop and exploit techniques for determining crystal structures of high pressure (and simultaneously, if possible, high temperature) polymorphs in the range of 50 kb and 1000 degrees C. Structure data are needed for innumerable polymorphs for general understanding of properties of condensed phases.

The diamond anvil cell is being utilized in single crystal diffraction studies using precession techniques. At present a beryllium unit is in operation and has proved useful in unit cell and space group determinations. Suitable absorption corrections have been worked out and the method is presently being applied to actual determination of atomic positions of a material stable only above 12 kb. The major problem arises from a high background on the films produced by incoherent scattering by the beryllium cell. The background limits the quantity of data obtainable.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0212, REINFORCED PLASTIC STRUCTURES
E.A. BUKZIN, U.S. Navy, Ship Systems Command, *Washington*, *District of Columbia* 20360

Objective: Develop high performance/high strength and modulus (lightweight) ship and submarine structures for advanced applications employing fiber reinforced plastics. Deck houses, masts, railings, etc for large ships where weight and microwave transmission problems are indicated; and deep submergence hull and appendage applications. Metallic materials are limited in depth capability unless augmented with considerable quantities of supplementory buoyancy.

Approach: While strength weight ratio of glass fiber and other fiber reinforced laminates are very attractive when small-scale tests are performed many problems such as fatigue, impact resistance, water absorption, long term stability, creep, closures, fabrication, etc need to be solved before their use can be specified for critical applications. These problems will be explored. For large boat hulls and structural components by tests of scale models. A survey of the state-of-the-art and latent progress will be made. Applicable design and production criteria will be assessed along with the cost effectiveness as compared with wood and aluminum. For deep submeregence applications the approach will be as follows: Design, fabricate and test small-scale models including typical structural details to determine the material response to realistic loads and environment including short-term hydrostatic loading; creep, fatigue, aging, and dynamic loads. Compare results with those obtained in tests of models using other candidate materials and determine realitive merit. If warranted, fabricate and test models of sufficient size to positively demonstrate potential of fiber-reinforced hulls for 20,000 ft operations. Effort is through industry and Navy Labs.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0213, STRUCTURAL PLASTICS-DEEP SUBMERGENCE
E.A. BUKZIN, U.S. Navy, Ship Systems Command, *Washington*, *District of Columbia* 20360

Objective: Develop fiber reinforced plastic composite materials, particularly glass reinforced plastics (GRP) and the fabrication technique quality assurance and inspection criteria to provide designers with reliable design data to employ such materials for deep submergence structures in vehicles for use where the weight displacement ratios of metals are unsuitable or less promising. The potential economic factors of cost, reliability and maintainability are additional stimulants for the use of the technology with these materials as compared to steel, titanium and aluminun alloys. The technology of GRP and the fundamental understanding of properties are further advanced than such materials as massive glass and ceramics which are competitors for such materials application.

Approach: The following efforts are underway and planned through industry and at Navy labs in conjunction with the studies on models and structures: interface problems of fiber, finish and matrix from the surface chemical, bonding and microstructure standpoint. Higher compressive strength, modulus and shear strength through the development of higher strength matrices. (i.e. new epoxy resins) and pregregs. Microvoid minimization will achieve many if not all of the desired properties. Improved test assessment of cyclic fatigue and creep factors in the sea environment along with water permeation effects and methods to control same.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0214, BUOYANCY MATERIALS
E.A. BUKZIN, U.S. Navy, Ship Systems Command, *Washington*, *District of Columbia* 20360

8. ENGINEERING AND TECHNOLOGY

Objective: Low density materials with bulk modulus equivalent of higher than sea water is required for use in filling voids of today's submarines and surface ships to provide buoyancy for deep submergence vehicles, buoys and other structures whose weight displacement ratio is greater than water at the depth of interest and in addition, those materials provide shock protection for surface ships. Currently, syntactic foam (glass microspheres dispersed in a resin matrix) is available at a density of 43 to 44 L65/cu ft for use at 20,000 ft dept. Densities as low as 25 lbs/cu ft are required for future vehicles. It is planned to develop material system with the following densities: 30 and 25 PCF in the next five years, coordination will be maintained on these developments with those going in conjunction with the DSSP (PM 1) program for the development of the DSSV.

Approach: The development of lower density syntactic foam modules will involve the incorporation of larger glass ceranic spheres with the matrix in some predetermined mix. Improved resin matrices and spheres of varying diameters will be included in these studies. The major limitations involve reliability under cyclic loading sympathetic implosion of glass or ceramic spheres. Modular design and nondestructive test methods and standards which will be studied. Techniques of measuring and assuring uniformity of low density foam used in large voids of surface ships will be undertaken. This effort will be undertaken through industry & at Navy Labs.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0215, DIELECTRIC MATERIALS

E.A. BUZKIN, U.S. Navy, Ship Systems Command, *Washington, District of Columbia* 20360

Objective: With respect to dielectric materials, the task area will result in the following: develop a short term accurate method of classifying dielectric materials in terms of thermal endurance (time and temperature), 2 years and 300 deg C. Develop embedding compounds for deep submergence (23,000 ft) flooded electric motors; where high thermal conductivity is required and electronic packages resistant to deep submergence environments (20,000 ft). Update and develop specifications for dielectric materials particularly varnishes, sleeving, resistors and capacitors to reflect the current state-of the-art and improve same as in the case of the studies related to the carborane polymer studies.

Approach: Temperature classification studies are being made employing thermal gravimetric analysis (TGA) and differential thermal analysis (DTA) studies and relating same to long term tests. Other methods to assess thermal endurance of dielectrics will be studied as well for specific materials such as diallyl phthalate (DAP) compounds. Navy developed embedding materials will be evaluated for induction motor stators for deep submergence. Designs and materials will be modified as test results dictate. Actual deep ocean exposures will be made on sample stators. Improved thermally conductive compounds will be employed using impregnating techniques developed by a Navy laboratory previously, with alumina in an epoxy matrix. Evaluate new and improved dielectric materials, including magnet wire and devise test methods as necessary to upgrade materials and specifications. Effort is through industry and at Navy labs.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0216, PRESERVATION OF WOODS IN THE MARINE ENVIRONMENT

J.R. DEPALMN, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

Objective: This effort will lead to a better understanding of fungal processes and wood boring animal action which each year account for approximately $50,000,000 in wood destruction in the marine environment. Data are necessary to establish a baseline for understanding the composite ecology of wood surfaces and the interrelationships between wood destroying animals and associated microorganisms.

Approach: Six large and 36 small pine test blocks have been submerged at each of 20 worldwide test sites. These blocks will be periodically examined and estimations made of marine borer and fungal activity. Three of the test sites are in the United States territorial waters. Data from these test sites will be coordinated with data from the other test sites.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0217, SUPPORTING TECHNOLOGY AT NAVAL RESEARCH LABORATORY

V.J. LINNENBOM, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

The development of improved techniques and instrumentation for work at great depths: and the development of an understanding of the part played by microorganisms in such Navy problems at marine fouling.

In deep ocean technology the approach is to develop reliable systems and components by acquiring off-the-shelf items for evaluation of by developing new instruments of high reliability. Microorganisms including single species of mixed systems are cultured in the laboratory and the systems are fractionated and the organic matter characterized biologically and biochemically. Field work evaluates the role of such organisms in producing peculiar distributions of matter.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0218, METAL ANALYSIS/TEST INSPECTION

B.B. ROSENBAUM, U.S. Navy, Ship Systems Command, *Washington, District of Columbia* 20360

Objective: Develop techniques and equipment for nondestruction testing (NDT) of ship hulls, frames, weldments, machinery and piping systems. There is a particular need for ultrasonic tests (UT) to inspect Tee welds in inaccessible locations. Inspection of all Tee welds of the hull integrity envelope of a modern submarine, using present procedures would require over 2500 man-days per ship for initial inspection only, with the ship in dry dock 5 to 6 months. The tests must be reliable, reasonably rapid, and quantitatively meaningful. Also, develop means for detecting crack initiation and growth after welding and for monitoring carck growth rate in-service e.g. while submerged.

Approach: (A) Develop and evaluate portable automated UT system for detecting and recording defect types, locations and sizes in hull weldments (1970); (B) Evaluate an acoustic spectrometer (Dickinson) system for remote UT of hull welds, Bu multiple transducers and computerized triangulation (1973); (C) Evaluate stress-wave analysis techniques (SWAT) for measuring fatigue crack growth in weldments to establish adequacy of nut accept-reject criteria and to monitor in-- service crack growth in submarine hulls (1970); (D) Investigate fluoroscopy for inspection of castings and weldments (1970); (E) Investigate ultrasonimage systems to replace point-by-point scanning (1972); (F) Develop correlations between eddy current test (EC) indications for tubing and metallurgical defects, and establish acceptance criteria (1970); and (G) Develop and evaluate electronic UT calibration blocks to determine crack size and orientation, and effects of specimen finish and crack interfaces, on evaluation (1970).

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0219, STRUCTURAL TITANIUM ALLOYS -100 KSI YIELD STRENGTH

B.B. ROSENBAUM, U.S. Navy, Ship Systems Command, *Washington, District of Columbia* 20360

Objective: Develop a weldable titanium alloy of 100,000 psi (min) yield strength for deep submersibles but with further applications for weight critical high-speed surface craft such as hydrofoils and captured-air-bubble ships where high strength-weight ratio is required. The material must have adequate toughness, e.g., drop-weight-tear-test value of 2000 ft-lb (min) at 30 F transverse section; be homogeneous and weldable in sections up to 4 in thick; and not susceptible to stress-corrosion cracking in sea water. Calculations show that for a cylindrical 20,000 ft DSSV, a Hy 100 Ti is equivalent to a Hy 170 steel; for an 8 ft diameter sphere, to a Hy 225 steel. Such an alloy, including heavy section welding technology should be ready for prototype marine structural application by July 1968.

Approach: NSRDC (Annapolis) coordinates this task area and is responsible for alloy development and mechanical property and physical metallurgy investigation. NRL determines full thickness fracture toughness characteristics and toughness criteria; also stress-corrosion cracking susceptibility and fatigue crack growth characteristics. NASL is developing techniques for forming, welding, and nondestructive testing of heavy sections. Fabrication and quality control procedures developed in the laboratory will be applied in the construction of prototype structures and models which will be evaluated for marine use.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0220, STRUCTURAL TITANIUM ALLOYS -120/150 KSI YIELD STRENGTH

B.B. ROSENBAUM, U.S. Navy, Ship Systems Command, *Washington, District of Columbia* 20360

Objectives: Develop a titantium alloy of 120,000 to 150,000 PSI yield strength for deep submersibles and high speed surface craft such as hydrofoils where high strength-weight ratio is needed. It must have minimum drop-weight tear test toughness of 2000 ft lbs at 30F (transverse), be weldable in up to 4 in thicknesses, and resist stress- corrosion cracking in sea water. On a strength-to-weight basis, Hy 120 TI is equivalent to Hy 200 steel and Hy 150 TI corresponds to Hy 250 steel. For deep diving vehicles with hull weight/displacement ratios low enough for a useful payload, materials in this ranges are necessary. Titanium of 120 KSI has no real compltition from steel in the near future. The TI-120 Y S should be ready for marine applications by September 1969; TI-15 Y S will take longer.

Approach: TI alloys of this strength are necessarily two-phase (alpha-beta) type. Extra-low interstitial (Eli) grade TI-6A-4V is being investigated as an Hy 120 alloy. NSRDC (Annapolis) coordinates this task area and is responsible for alloy development and mechanical property and physical metallurgy investigation. NRL determines full- thickness fracture toughness characteristics and toughness criteria; also, stress-corrosion cracking susceptibility and fatigue characteristics. NASL is developing techniques for forming, welding, and nondestructive testing of heavy sections. Fabrication and quality control procedures developed in the laboratory will be applied in the construction of prototype structures and models which will be evaluated for marine use.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0221, HY 130-150 STRUCTURAL STEELS

B.B. ROSENBAUM, U.S. Navy, Ship Systems Command, *Washington, District of Columbia* 20360

Objective: Develop and evaluate a structural steel in the 130,000 to 150,000 PSI yield strength range (HY 130/150), weldable under shipyard conditions in sections up to 4 in. thick. It must have adequate toughness (charpy v-notch, tranverse of 50 ft. -lbs minimun at 0 degrees F), resistance to low-cycle, high-strath fatigue and minimum susceptibility to degradation under stress in sea water.

Approach: The major effort carried out by industry and Navy labs has resulted in the development of a family of Sr, Ni-Cr-Mo-V low carbon steels as optimum base metal compositions; the effect of residual elements (P, S, N, Al, O) have been established; weld wire compositions to permit weld metal properties equal or better than base metal are being developed; optimum melting, deoxidation practices are being established for producing commerical plates (up to 3 in.), forgings and castings. Full thickness fracture toughness criteria for base metal and weldments are being determined; also, crack propagation characteristics, service fatigue limits, service stress-corrosion behavior. The effects of thermal cycling during welding, of stress relief, and of weldment restraints on fatigue are being determined. Welding procedures are being evaluated by explosion bulge tests of heavy section weldments.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0222, HY 80-110 STRUCTURAL STEELS

B.B. ROSENBAUM, U.S. Navy, *Washington, District of Columbia*

Objective: Develop and fully evaluate structural steel in the 100,000 to 115,000 psi yield strength range (HY110), meeting the toughness requirements of current HY80 structural steel. The HY110 base metal will be an upgrading of the HY80 type alloy. The pressin need is for welding wire to permit an overmatched weldment strength.

Approach: (A) Through industry and Navy labs develop and evaluate base plate to reduce weld heat affected zone (HAZ) cracking and lamination tendencies at HY100-110 levels--being performed under NavShips contract NOBS 94464. (B) Develop improved electrodes of 115 ksi y s, with consistently reproducible weldment properties. Greatest effort is required in covered electrodes: metal-inert gas (MIG) electrodes will probably result from existing contracts. (C) determine characteristics of new electrodes, and weldments therefrom, with regard to fracture toughness, fatigue, shock, and corrosion.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0223, ENERGY CONVERSION MATERIALS AND COMPONENTS

B.B. ROSENBAUM, U.S. Navy, *Washington, District of Columbia*

Objective. Develop materials for specialized application in direct energy conversion (DEC). Materials limitations are a major restriction to successful development of promising DEC technologies for Navy requirements. Major objective is development and evaluation of materials and components for fuel cell power plants: particularly for ambient pressure (free flooded) cells capable of operating for long periods under transient conditions, between sea level and 20,000 ft submergence. Components must be compatible with hydrazine fuel, hydrogen peroxide oxidant, and alkaline electrolytes (KOH) in anticipated ambient ocean environment. Also, the kinetics of reactions of various fuels with various electrode materials must be quantified. The developments are applicable to plants for deep submergence vehicles, swimmer delivery vehicles, and stationary underwater power plants. A long term objective is development of thin-film oxide (solid) electrolytes for ultimate use in high temperature direct hydrocarbon fuel cells.

Approach. Hydrazine-hydrogen peroxide fuel cells. Phase I-determine stability and electrochemical behavior of single cells and cell stacks in high pressure oxygen, hydrogen peroxide, hydrazine, potassium hydroxide seawater environment. Evaluate thermal and electrical insulating materials. Phase II--investigate long term effects of high pressure conditions on electrode kinetics and stability and on cell performance. Phase III--study nitrogen solubility in KOH electrolyte and effects of temperature and pressure changes on gas evolution (possibility of bonds during ascent from deep ocean). Phase IV--stability characteristics; handling and dissociating hydrogen peroxide under deep ocean conditions; Effect of impurities and friction on hydrogen peroxide dissociation. Thin film oxide electrolytes-phase I--develop acceptable techniques for producing thin film and single crystals of promising semiconductor electrolytes and quantitatively establishing their electrical and crystallographic properties. Phase II--study oxygen polarization, effects of field gradients on electrical and electronic properties, and effect of time and temperature on crystallography and properties. Phase III--construct and evaluate small experimental test cells. Effort is carried out through industry and at Navy labs.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0224, HY 180/210 STRUCTURAL STEELS

B.B. ROSENBAUM, U.S. Navy, Ship Systems Command, *Washington, District of Columbia* 20360

Objective: Develop and evaluate a structural steel in the 180,000 to 210,000 psi yield strength range (HY 180/210) with adequate notch toughness, fatigue strength, and general corrosion and stress-corrosion resistance.

Approach: Investigate work through industry and Navy labs includes concurrent efforts in base metal development, heat treatment, joining, and structural evaluation. Base metal and weld filler metal development includes precipitation hardening maragins steels, the proprietary Hp 9Ni-4Co family of quency-hardening steels, and most promising, a compositional dual-strengthened group combining both hardening phenomena. Heat treatment includes a consideration of the proprietary rapid multiquenching technique for grain refinement. Basic studies include strengthening mechanisms, embrittling phenomena, and effects of residual elements. Suitable weld filler metals which do not require

post heat treatment must be developed and advanced joining techniques will be explored. Fracture toughness criteria will be established, and fatique, corrosion, stress corrosion evaluated. Fabricated models will be tested under simulated service conditions in appropriate Navy facilities.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0225, MARINE FUNGI DEGRADATION

***S.P. MEYERS*, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124**

The objectives of this research are (1) investigations of early fungal infestation to establish the significance of this population in wood degradation and its contribution to the biology of associated marine organisms, and (2) analysis of specific fungal destruction of cellulosic and other higher molecular weight substances.

Data are necessary to establish a baseline for understanding the composite ecology of wood surfaces and the interrelationships between wood destroying animals and associated microorganisms. This project will lead to a more accurate picture of fungal processes, and indirectly, to the mechanisms whereby wood boring animals benefit from activities of associated fungi. A clear understanding of the role of fungi in biodeterioration processes could lead to better methods for protecting pilings and other wooden objects placed in the sea. The yearly wood destruction loss in the United States marine environment is estimated at $50,000,000.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0226, COMBUSTION OF RESIDUAL FUEL WITH MASSIVE RECIRCULATION

***UNKNOWN*, Illinois Institute of Technol. , Graduate School, *Chicago, Illinois* 60616**

This research provided quantitative data on the external recirculation rates required to reduce deposition and corrosion of metal exposed to combustion products from low grade residual fuel. Measurements of the effect of massive recirculation on combustion noise were made that showed that combustion noise was reduced to that of the background equipment, a reduction of 17 db. Conclusion was that massive recirculation of combustion gases back into the flame area produces: (1) substantial reductions in deposition and corrosion rate. With sufficient recirculation, the corrosion rate with residual fuels can be brought down to that of distillate fuel; (2) high vanadium accumulation in the recirculation line; (3) flame changes from an overventilized atomized flame to an underventilated, vaporized flame with very low flame luminousity; and (4) combustion noise reduction by a substantial amount - (15 db. in the tests).

The report PB-NO. 177-747 is available from the Federal Clearinghouse for Scientific and Technical Information, Springfield, Virginia 22151.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0227, FRICTIONAL RESISTANCE HULL SCALE AND COATINGS

***UNKNOWN*, U.S. Navy, Ship Research & Dev. Center, *Caderock-washington, Maryland* 20007**

To determine the effect on frictional resistance from the normal build-up of paint, rust scale and localized peeling on a ship's hull, and the relative resistance characteristics of Maritime and Navy paints.

DESCRIPTION: In a joint project with SNAME Panel a 21-ft. friction plane first painted with Navy paints Mil-P-l5929A Undercoat, Mil-P l59328B Primer, and then with the Navy primer and MarAd paints 52-MA- 403C Topcoat, 52-MA-401B (3) Undercoats, has been run at 3 feet immersion in the towing tank. The results of these tests are being analyzed to determine the relative resistance of the coatings.

Tests are under way with the same friction plane covered with plastic molds made from master molds which were taken on a commercial vessel while in dry dock under the three following conditions: a. Ship's bottom 'as is' when drydocked. b. After normal treatment for annual drydocking; i.e. hand wire brushing and scraping followed by application of one coat of anti-corrosive and one coat of anti-fouling paints. c. After blasting plate to clean metal and applying complete five coat anti-fouling system.

When completed, these tests will be analyzed to determine the relative effect of procedures a., b., and c. above, on ship resistance.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0228, MICROBES AND CORROSION

***W.P. IVERSON*, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Gaithersburg, Maryland* (NAONR-14-67)**

This research will consider anaerobic corrosion of metal and the part played by microorganisms in depolarizing cathodes. This includes the role of iron in metabolism of microorganisms, the role of substrate and electron donors in possible extracellular enzyme action in a corrosive environment, and the role of metal in the physiology of microorganisms.

Corrosion is a serious problem in sea structures exposed to the bottom mud zone. Very little is known about the fundamental biological, chemical, and physical processes whereby microorganisms contribute to corrosion. A combined biological metallurgical approach to the problem is essential.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0229, EFFECT OF INTERFIBER SPACING ON THE HIGH TEMPERATURE DEFORMATION OF A1-A13NI COMPOSITES

***H.C. LEWIS*, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139**

To investigate the formability and high temperature tensile strength of Al-Al3Ni fiber composites, directionally solidified tensile speciments were grown at four growth rates ranging from 3.5 to 9.4 cm/hr. and two nickel weight fractions, 6.13 and 6.2 wt. temperatures ranged from room temperature to 500 degrees Centigrade. The results showed a steep decrease in tensile strength with increasing temperature. Above 250 degrees Centigrade, however, the tensile strengths leveled off. The 6.2 wt % Ni composite showed better strength than the 6.13 wt % Ni composite. The tensile strengths increased with increasing growth rate from 3.5 to 5.2 cm/hr. At yet higher growth rates, it was found that microstructural defects were more prevalent than at the lower rates and the strengths decreased. The defects encountered were fiber depleted grain boundaries and banded areas of misaligned fibers. When both defects occurred simultaneously, the specimen failed in matrix shear with a low ultimate tensile strength. The percent elongation of the samples was generally from 1 to 2% before the ultimate strength was reached. For those samples that had a sufficiently defective microstructure, elongation was extensive after yield and occurred uniformly over the gage length. Multiple shear planes were aligned parallel to the eventual failure plane. Strain rate sensitivity tests on specimens that showed unusual elongation after yield resulted in a low strain rate sensitivity index that decreased with increasing % elongation.

SUPPORTED BY Massachusetts Institute of Technology

8.0230, PRODUCTION OF PLATES OF FIBER COMPOSITES BY SOLIDIFICATION, FORMING AND A COMBINATION OF BOTH

***W.L. MARSH*, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139**

The purpose of this investigation was to determine the feasibility of unidirectionally solidifying the Al3Ni eutectic in plate form. The plates solidified displayed good fiber formation but poor fiber alignment. Tensile strengths achieved were nearly twice that of the as cast alloy but only half of strengths achieved in cylindrical specimens. Plates with thickness to width ratios of 2, 25, and 75 were grown and tested. The hot pressing of Al3Ni plates was found to increase the strength to more than twice that of the as cast alloy. However, it was found that the bond between

the plates was weak to the extent that the layers could be peeled apart.

SUPPORTED BY Massachusetts Institute of Technology

8.0231, TEMPERATURE AND STRAIN RATE DEPENDENCE OF DEFORMATION IN AL-3NI-AL COMPOSITES

R.W. RENDER, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

The intent of this investigation is to determine the elevated temperature properties of the Al3Ni-Al eutectic fiber composite. Specimens were grown from a 6.13 weight percent nickel eutectic alloy. Tensile tests were conducted over a temperature range from room temperature to ninety-seven percent of the absolute eutectic temperature. The maximum strength of the fiber composite decreased linearly from 44,000 psi at 25 degrees Centigrade to 5,500 psi at 600 degrees Centigrade. These strengths are superior to 2024 T6 and 7075 T6 high strength aluminum alloys at temperatures above 300 degree Centigrade. The room temperature strength of the as cast alloy is approximately 13,000 psi.

The fiber morphology remained stable and did not appear to coarsen throughout the range of test temperatures. Deformation of the composite showed a low dependence on temperature and strain rate.

SUPPORTED BY Massachusetts Institute of Technology

8.0232, PILING PRESERVATIVES THRESHOLD STUDIES

B.R. RICHARDS, William F. Clapp Laboratories, *Duxbury, Massachusetts* 02323

Objective: To determine what changes occur in woods (treated with various preservatives and exposed in coastal waters) to cause these treated woods to lose their resistance to attack by marine borers and fouling organisms.

Approach: Wood panels of several woods were treated with various preservatives and amounts of preservatives. Panels of 18 different treating systems were placed under exposure in Boston Harbor, Mass. in July 1964. In the same month 27 systems were exposed in the waters of Whightsville Beach, N. C. Sufficient samples were prepared to remove 3 samples of each treatment system plus one control panel from each location every 6 months for 5 years plus additional samples for subsequent removal annually. When removed the test panels are chemically and biologically analyzed for changes.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0233, DEEP-WATER FOULING

H. TURNER, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (NONR)

Analysis of data will be concluded on research undertaken to determine the quantity and kinds of sedentary marine organisms that attach and grow on installations set at a series of depths in the open ocean and form a fouling community that may affect the performance of instruments. Studies were also conducted to devise simple, reliable moorings that could be set from relatively small vessels at a reasonable cost. The phenomenon of damage to deep-water moorings and submerged installations by predaceous fishes was investigated.

As more activities are being planned for deep ocean localities, it is essential that the ecological characteristics of this environment be better understood. The little information available makes it clear that assumptions based on extrapolation from shallow water conditions are invalid in most cases. Whether or not biological fouling plays an important role at great depths and what its nature may be, needs to be determined. The nature and severity of attack by abyssal fishes on moorings and other artifacts in the deep ocean must be known as well as the identification of the animals involved.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0234, WAVE FORCES ON BREAKWATERS

A.M. KAMEL, U.S. Army, Waterways Experiment Sta. , *Vicksburg, Mississippi*

The objective of this project is to develop a theory and obtain experimental data on wave pressures from which the magnitude, duration, and location of wave pressures and impact forces on full-scale breakwaters of the vertical wall and composition types can be predicted.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0235, BIOLOGICAL OCEANOGRAPHY AND DETERIORATION, POLYMER STUDIES

E.C. FISCHER, U.S. Navy, Applied Sciences Lab. , *Brooklyn, New York* 11251

Objective: To identify the chemistry and biology of high molecular weight friction reducing bio-polymers.

Approach: Chemical and physical studies will be made on the isolated polymers followed by the characterization and correlation of polymeric substances with plankton species. A broad based theory of occurrence, use and importance will then be formulated.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0236, BIOLOGICAL OCEANOGRAPHY AND DETERIORATION, DEEP OCEAN-HIGH PRESSURE BACTERIA

E.C. FISCHER, U.S. Navy, Applied Sciences Lab. , *Brooklyn, New York* 11251

Objective: To determine the role of deep sea microorganisms in the corrosion and deterioration of deep submergence structures and instruments placed on the ocean floor, and deep research vehicles. To develop suitable corrosion preventive methods and provide consultation on problems involving biological oceanography.

Approach: Obtain specimens of world wide ocean bottom sediments and determine chemical and biological content. Isolate, identify and determine corrosive influence of microorganisms in laboratory simulated deep sea environments. Determine the relation of ecology to the bottom zone influence in accelerating corrosion rates. Determine the mechanism of microorganism attack on metals and organic materials. Correlate lab results with natural deep sea immersions. Determine influence of galvanic metal couples and organic materials on microorganism activity, the effect of environment on this influence.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0237, EVALUATION OF BOOTTOP PAINT SYSTEMS FOR OCEANGOING SHIPS IN A BOOTTOP PAINT TESTING MACHINE

UNKNOWN, Battelle Memorial Institute, *Columbus, Ohio* 43201

This project evaluated the use of ship bottom paints under conditions which partially simulated the water flow conditions to which a paint film is subjected on a ship at sea. Thirty-three coating systems were tested and evaluated by applying the paint films to a cylindrical surface which is rotated constantly in a water tank.

The studies showed the importance of proper application, surface preparation, and drying between coats. The paints were separated into groups rated as: best, intermediate, and poorest performance. Both conventional and high-build vinyls were included in the group, and all systems used a poly-vinly butyral wash primer.

Excellent performance of high quality catalyzed epoxy coatings was noted. The report discusses this performance with respect to application over inorganic zinc silicate coatings. Factors which may have contributed to the various types of failures were noted in several of the films. One of these factors was that the lack of sandblasting contributed to poor paint performance.

Each film is identified by source, coating type and color, number of coats, method of application, drying time, and thicness. Certain of the test drums were photographed on black and white film to illustrate condition after certain numbers of days of continuous rotation in seawater at speeds simulating a ship moving within the range of 18.8 to 20 knots. The report PB No. is available at the Federal Clearinghouse for Scientific and Technical Information, Springfield, Virginia, 22151.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8. ENGINEERING AND TECHNOLOGY

8.0238, MOBILITY OF OIL-TYPE PRESERVATIVES IN IMMERSED WOOD

D.J. MILLER, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

Objectives: To describe the movement of oil-type preservatives in treated wood immersed in water.

Abstract of Procedures: Laboratory tests will examine the effects of water temperature and flow on migration of creosote along radial and longitudinal axes of treated specimens of Douglas fir and southern pine sapwood. Marine exposure to induce and describe patterns of creosote migration in small piling immersed in marine waters.

SUPPORTED BY Oregon State Government

8.0239, FOULING OF SENSORS

W.E. PEQUEGNAT, Texas A & M University System, Graduate School, *College Station, Texas* 77843 (NONR)

The principal objectives of this task are to discern the nature of the accumulation of fouling organisms upon artificial substrates, some of which are partially protected by equatorial attachment of a teflon band impregnated with organotin, to observe the impact of various parameters on the nature and rate of growth of the accumulation; to evaluate the effectiveness of organotin as an inhibitor; and to suggest means of providing functional integrity of sensors during relatively long periods of immersion in the sea.

This task is expected to provide a better understanding of the parameters affecting oceanographic sensors which might be employed by environmental systems implanted for prolonged periods.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0240, ANTI-FOULING MEANS FOR MARINE PROPELLERS

S. HAWKINS, Robert Taggart Incorporated, *Fairfax, Virginia* 22030

The serious effects upon ship performance of a fouled propeller have been substantiated and a means devised to prevent this fouling from occurring.

SUPPORTED BY Robert Taggart Incorporated

8.0241, THE ROLE OF MARINE ORGANISMS IN THE DEGRADATION OF NAVAL MATERIALS

J. LISTON, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

This research within the Task Area of Marine Microbiology is concerned with rates and mechanisms of degradation, solubilization, and mineralization of organic residues from marine plants and animals by marine bacteria. Experiments are being conducted in a series of model sea bed systems which provide conditions similar to those actually occurring in the sea. These models are dynamic flowing sea water systems which permit observations to be made throughout a complete cycle of microbial enzyme-catalyzed transformations.

This investigation relates to microbial transformations as they effect functioning and maintenance of Navy hardware.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0242, MARINE PILING ANALYSIS

T.C. SCHEFFER, U.S. Dept. of Agriculture, Forest Service, *Madison, Wisconsin*

To evaluate wood treated with waterborne copper compounds; conduct follow-up studies on pilings that have given either unusually good or very poor service; and improve methods for assaying treated piling and analyzing for creosote. Samples of piling having authentic histories are obtained and analyzed in the laboratory. Short fence post sections of both Southern pine and Douglas fir were treated with a variety of preservatives using two treatment methods and were exposed at Key West and San Diego. Wood specimens examined in connection with this Work Unit also undergo a microbiological study.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0243, MICROBIOLOGICAL INVESTIGATIONS OF THRESHOLD PANELS

R.L. YOUNGS, U.S. Dept. of Agriculture, Forest Service, *Madison, Wisconsin*

To determine if marine fungi and bacteria are a significant factor in the degradation of marine timber preservatives or in the initiation of attack by marine borders.

Marine exposed panels used in connection with other existing investigations are being sent to the Forest Products Laboratory for examination. The examinations include identifications of the principal marine fungi and bacteria and determination of the relationship between species of micro-organisms and kind of preservative, kind of wood, or locality of exposure. Cultures of isolated organisms will be maintained for possible continuation of study in order to determine quantitatively the capacities of the organisms for degrading preservatives.

SUPPORTED BY U.S. Dept. of Defense - Navy

8K. MINERAL SAMPLING, EXTRACTION, AND PROCESSING

(*see Also Chapter 7a on Economic Geology*)

8.0244, LABORATORY STUDIES TO CORRELATE ENGINEERING PROPERTIES OF MARINE PLACER MATERIALS WITH SAMPLING TOOL PERFORMANCE

E.L. CORP, U.S. Dept. of Interior, Marine Min. Technol. Ctr., *Belvedere - Tiburon, California* 94920

Extensive background work has been done to become familiar with the current state-of-the-art in submarine geotechnique. Based on this work, a tentative classification system has been devised for marine placer deposit so that samples obtained at sea and soils used in MMTC laboratory can be adequately described. *The test equipment required for measuring* these classification parameters has been procured and is currently in storage awaiting completion of the environmental mechanics laboratory to house it. This laboratory will be set-up and placed in operation following the two summer offshore campaigns.

Initial utilization of the laboratory will be for additional engineering properties tests on the offshore samples and for conducting a series of tests to evaluate the effects of gold migration during sampling. In addition, engineering properties testing will be done to assist the work of other projects.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0245, LABORATORY MODEL STUDIES OF PENETRATION INTO A SIMULATED COHESIONLESS DETRITUS

M.J. CRUICKSHANK, U.S. Dept. of Interior, Marine Min. Technol. Ctr., *Belvedere - Tiburon, California* 94920

Previous work by Colp (1965) on 'An experimental investigation of the continuous penetration of a blunt body into a simulated cohesionless soil' has shown the value of using a roller bearing matrix to simulate a detritus and photographing the pressure distributions and particle displacements resulting from penetration of the matrix by a solid body.

The results of such tests using shapes of varying geometry and using different methods of application of the penetrating force could be of significance in the development of undersea sampling and excavation techniques. The major part of the experimental setup necessary to conduct the tests has been obtained, but actual testing has been postponed until laboratory facilities are available.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0246, ENGINEERING EVALUATION OF EXISTING DREDGE SYSTEMS AND OPERATIONS

M.J. CRUICKSHANK, U.S. Dept. of Interior, Marine Min. Technol. Ctr., *Belvedere - Tiburon, California* 94920

This is a continuing study of dredging operations which will allow maximum knowledge to be acquired of past and present systems in industrial use. Analysis of these systems will permit sound decisions to be made in planning future areas for research and development and will permit realistic projections to be made for proposed marine mining operations requiring dredging.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0247, DEVELOPMENT OF AN ELECTRONIC METHOD FOR THE AUTOMATIC SHIPBOARD RECORDING OF DRILL PERFORMANCE DATA

R.L. JENKINS, U.S. Dept. of Interior, Marine Min. Technol. Ctr. , *Belvedere - Tiburon, California* 94920

In order to be able to better analyze the performance of the delineation devices aboard the ship an electronic data acquisition system has been designed and assembled for recording on strip chart and magnetic tape, 15 parameters that affect the operation. The following data will be recorded: 1. Time 2. Drill operator's voice, giving depth of hole, sample interval, and any problems encountered. 3. Ship's roll and pitch. 4. Velocity and direction of ocean currents. 5. Velocity and direction of wind. 6. Speeds of electric motors driving hydraulic water pumps. 7. Hydraulic pressure (2). 8. Air or water pressure and flow to drill pipe. 9. Impact force applied to drill pipe. 10. Penetration rate of drill bit into sediment.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0248, DEVELOPMENT OF DIAMOND DRILLING TECHNIQUES, FOR PHOSPHORITE DEPOSITS, USING STANDARD TOOLS PLUS BUOYANCY TANKS

A.H. LENSE, U.S. Dept. of Interior, Marine Min. Technol. Ctr. , *Belvedere - Tiburon, California* 94920

Initial phases of drilling operations conducted by MMTC with rotary equipment have demonstrated poor capabilities for coring in anything but solid bedrock. Drilling operations in unconsolidated sediments utilizing percussion or vibratory driving and water or air flushing improved the volume of sample recovered but the sample poorly represented the physical nature of the sediment penetrated. Recent emphasis has been devoted to the development of equipment which will provide a relatively undisturbed core of even loosely consolidated sediments in shallow ocean depths. These parameters of research have not been expanded to include extremely broad ranges of sediment consolidation in relatively deeper waters.

Arrangements are proceeding with E. J. Longyear Company of Minneapolis to test their recently patented, rotary, controlled buoyancy drilling system.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0249, DEVELOPMENT OF WIRE-LINE CORING TECHNIQUE FOR SAMPLING UNCONSOLIDATED DEPOSITS

A.H. LENSE, U.S. Dept. of Interior, Marine Min. Technol. Ctr. , *Belvedere - Tiburon, California* 94920

During the summer of 1967, MMTC conducted an offshore heavy metals research project off the southern coast of Seward Peninsula in the vicinity of Nome, Alaska. Results indicated that relatively rapid penetrations of shallow ocean-floor sediments could be accomplished from surface craft but only inconsistently yielding characteristics samples of the quality and quantity necessary for accurate delineation studies.

Though the Becker Hammer drill had been successfully adapted to ship-board operation, it produced samples reliable only for mineral content and identification analyses, not for studies of engineering properties. Therefore, the Becker drill system is being adapted to a wire-line coring technique capable of producing an essentially undisturbed sample of ocean-floor sediments. Initial tests will be made on the Oregon-California Marine Heavy Metals Project.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0250, DEVELOPMENT OF MARINE CHURN DRILL FOR SAMPLING UNCONSOLIDATED DEPOSITS

R.D. OBRIEN, U.S. Dept. of Interior, Marine Min. Technol. Ctr. , *Belvedere - Tiburon, California* 94920

A single wall drill pipe that will take a wire-line core barrel, will be driven by a 1,000-pound hammer encircling the pipe. Other innovations will be a conical topped buoyancy tank to maintain verticality when drilling starts and to guide the core barrel on re- entry to the device. The re-entering core barrel will be lowered on a sand line guided along the hammer hoist line by a small vaned trolly.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0251, LITERATURE SEARCH AND PRELIMINARY ENGINEERING STUDIES OF ENVIRONMENTAL PROBLEMS ASSOCIATED WITH MARINE DEPOSIT DELINEATION TECHNIQUES

R.D. OBRIEN, U.S. Dept. of Interior, Marine Min. Technol. Ctr. , *Belvedere - Tiburon, California* 94920

This will involve a search of the literature to acquire data generated by offshore oil drilling companies, JOIDES, or others regarding the effect on drill pipe of lateral loading caused by ocean currents as well as data on materials corrosion in sea water.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0252, LABORATORY MODEL STUDIES ON DISTURBANCE OF DETRITUS BY PENETRATION

D.E. STEPHENSON, U.S. Dept. of Interior, Marine Min. Technol. Ctr. , *Belvedere - Tiburon, California* 94920

One of the major problems of obtaining representative samples from marine deposits and meaningful data as to engineering properties is the amount of disturbance caused by the technique used. A quantitative study of this disturbance on a laboratory scale will give much insight into methods of penetration which can be used at sea to obtain a time representative sample.

The study will be done using a granular material submerged in hydro-carbon solution which will simulate water but will not disturb the material when it freezes. Models will be 6-inch diameter by 12- inch high cylinders of uniform sediments with known properties. The drill rod will be simulated by a 1-1/2' diameter pipe capable of being fitted with various bit configurations and capable of being driven by different method of energy application. After penetration is completed the model will be placed in a freezer until solid and then sectioned for study.

A three-dimensional observation of the disturbance in the core and surrounding sedments will be possible in the area of the drilled hole.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0253, LABORATORY MODEL STUDIES ON PRESSURE DISTRIBUTION IN DETRITUS DURING PENETRATION

D.E. STEPHENSON, U.S. Dept. of Interior, Marine Min. Technol. Ctr. , *Belvedere - Tiburon, California* 94920

Much work has been done on the response of soil and rock to large scale dynamic loading in the past few years, but as yet little is known of the behavior of marine material in dynamic loading. The work on this project is concerned with small scale loading and the effects it has on the placer-type deposits.

The project is designed around the use of unique pressure transducers and their ability to give meaningful results. If it is determined that useful data can be obtained with them several series of tests will be performed in the laboratory.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0254, FINITE ELEMENT TECHNIQUES

D.E. STEPHENSON, U.S. Dept. of Interior, Marine Min. Technol. Ctr. , *Belvedere - Tiburon, California* 94920

Mathematical models based on the finite element method of stress analysis is becoming one of the main tools in rock and soil mechanics for determining magnitude and direction of the stresses and displacements. In the finite element method of analysis, a continuous solid is modeled by an assemblage of a finite number of interconnected elements. The method's versatility is in the fact that each element can have completely different material properties and, in addition, linear relationships may be used. Any geometry or slope can be modeled for used in the method. The method will be applied to various problems of marine mining technology where it will be advantageous to know the response of the seafloor to load phenomena.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8. ENGINEERING AND TECHNOLOGY

8.0255, ACOUSTIC HOLOGRAPHY

D.E. STEPHENSON, U.S. Dept. of Interior, Marine Min. Technol. Ctr., *Belvedere - Tiburon, California* 94920

Recently the principle of reconstructed wave fronts has been extended to the formation of visual pictures of acoustical waves. This method yields better results than conventional acoustical lens systems especially in the presence of turbidity thereby making it a useful method for control of systems underwater. The method is based on the process in which the diffraction patterns of an object irradiated by sound waves is biased by a coherent reference wave and recorded; the record is then the acoustical hologram. A three-dimensional visual image can be created when the acoustical hologram is interrogated with a suitable coherent light source.

This will allow for the inspection and control of mining operations at depth in the ocean without the need for direct observation by divers or persons in submersibles.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0256, DEVELOPMENT, TESTING AND EVALUATION OF MODIFICATIONS REQUIRED TO ADAPT DRILLING SAMPLING SYSTEMS TO THE PLATFORM

K.E. TAYLOR, U.S. Dept. of Interior, Marine Min. Technol. Ctr., *Belvedere - Tiburon, California* 94920

To develop, design, test and evaluate the modifications and changes required to accommodate the various different types of drilling equipment presently planned for use on board the R/V VIRGINIA CITY, and any future requirements which might result from further research and development of drill systems.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0257, LABORATORY MODEL STUDIES OF COMPARTIVE METHODS OF PENETRATION OF DETRITUS

O. TERICHOW, U.S. Dept. of Interior, Marine Min. Technol. Ctr., *Belvedere - Tiburon, California* 94920

A survey of mining fragmentation technology has disclosed the existence of various methods available for in situ disintegration of marine deposits. The methods of penetration are conveniently classified by the type of energy applied to the working tool.

Mechanical energy which was the first to be investigated showed certain interdependence between the rate of energy application and the resistance to penetration of granular media.

Static penetration tests of a tubular body into sand have yeilded an understanding of the granular deposit response to static loading. Dynamic loading to determine the penetration characteristics, at high to very high velocities of the tube, are planned.

Sampling reliability has been tentatively evaluated in conjunction with information on relative disturbance of the sample, using data from the 1967 Alaskan field work.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0258, BACKGROUND AND EXPLORATORY STUDIES OF MATERIALS HANDLING IN THE MARINE ENVIRONMENT

O. TERICHOW, U.S. Dept. of Interior, Marine Min. Technol. Ctr., *Belvedere - Tiburon, California* 94920

This project has multiple aspects which can be conveniently divided into 3 major areas:

(1) Investigation of the energy requirements to remove mineral particles hydraulically from an unconsolidated granular deposit. This requires study of kinetic energy distribution of a submerged water jet to disrupt cohesion of particles. Other methods will be tested. (2) The development of certain marine mining systems may depend upon excavating equipment operating remotely on the seafloor. The process of mechanical cutting of the seafloor deposit by rotary process is relatively complex. Its efficiency depends on many external and environmental conditions. Analytical work is scant, and sole dependence is on the experimental approach. The proposed investigation will provide information in the areas which are now entirely uninvestigated or are obscure. (3) Related to the above is the study of methods for transporting materials from the seafloor. The transportation process is the continuation of the first step of underwater mining. The scope of the investigation will include determination of parameters which affect vertical or horizontal pipeline transportation of mineral particles or ore material to the surface for further processing.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0259, DEEP SEA MINING PROJECT

J.L. MERO, Ocean Resources Incorporated, *San Diego, California* 92121

Ocean Resources, Inc., an ocean exploration and mining consulting firm, was engaged to design a mining system and to test the system in about 1,000 feet of water for the mining of mineral containing rocks from the ocean floor. The equipment was designed and tested on an industrial production scale with hundreds of tons of rock being successfully dredged from the design depth. The test was highly successful in that the rock was recovered at a production cost well within that to be considered economic for the commercial mining of this type of material. The test was carried out in the Pacific Ocean.

SUPPORTED BY No Formal Support Reported

8.0260, VISCOSITY AND VISCOELASTICITY OF LIQUIDS AND GLASSES

J.E. MCKINNEY, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

To develop and improve techniques for the measurement of rheological properties of liquids and glasses (both low molecular weight and polymeric as functions of temperature and pressure, in the pressure range from 1 to 2,000 atmospheres. Viscosities of liquids in this pressure range are needed for both technological and scientific purposes (design of hydraulic systems, checking concepts in theories of transport phenomena), but validity of usual measurements has not been established. In the glassy range, where the approach to equilibrium is slow, the manner in which properties depend on both thermal and mechanical histories is not established.

Increase the frequency range of our dynamic bulk modulus measurements of polymeric liquids and glasses, needed to check current theoretical concepts. Establish the limits of validity of the torsion crystal viscometer, which seems to offer the best prospects of increasing the accuracy of viscosity measurements in the above pressure range. Examine the influence of both thermal and mechanical histories of PVT relations in the glassy and transition regions.

Progress: March through December 1967. A digital phasometer, capable of measuring phase angles to 0.01 degrees from 10 kHz to arbitrarily low frequencies was completed and tested. This is a significant improvement over anything previously available. In addition to our use with the bulk modulus apparatus, it is likely to find other applications. (The Navy Underwater Sound Laboratory at New London is already using it to check the performance of special amplifiers in sonar systems.) A companion instrument to measure voltage ratios at low frequencies was designed and constructed, and is being tested. The other needed modifications to operate the bulk modulus apparatus down to well under 1 Hz have been planned and should be constructed and assembled within a few months.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8L. PLATFORM DESIGN AND MAINTENANCE

(*ships, Buoys, Rigs, Submersibles, and Other Platforms.*)

8.0261, SHIP STRUCTURE LABORATORY TESTING AND ANALYSES

UNKNOWN, Univ. of California, Graduate School, *Berkeley, California* 94720

Purpose: To develop lower cost basic hull designs by structure simplification and by upgrading material/structural effectiveness.

Description: Analytical studies have been performed in the following areas of interest: structural response to slamming (wave impact); effect of variations in framing on fabrication cost; application of high strength steel; and methods for determining strength of platos and hull structures. A special drop weight test facility has been developed for slamming studies which utilizes relatively large specimens to represent ship bottoms. Using this facility, an indication of the effect on the pressure time history is being achieved for the following variables: (1) amount of air trapped between the ship bottom and the water surface, (2) the inertia of the slamming ship, and (3) the stiffness of the bottom plating. Empirical evaluations are also being made using a 40-foot structural model of a ship midbody section to verify some of the analytical results and to determine the merits of longitudinal framing for double bottoms with variations in hatch sizes, pillars and bulkheads while under the influence of simulated static wave conditions.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0262, ECONOMIC ANALYSIS OF THE SHIP MAINTENANCE FUNCTION

UNKNOWN, Litton Industries Incorporated, *Culver City, California*

Purpose: To devise a method for determining the most cost effective ship maintenance policy, considering investment, shipboard maintenance and shore maintenance factors.

Description: Investigations are being undertaken to develop a method for determining the most economic means for performing ship maintenance regardless of operator, trade route or ship characteristics. The initial effort is directed toward a review of ship operator records to determine what data are available and current policies. Following this review a data plan will be prepared prescribing specific new basic data that will be needed, ships and voyages to be utilized in a survey to obtain these data, and the supplementary data to be collected in order to present a complete matrix on ship maintenance.

Once collected and analyzed, alternative maintenance policies will be investigated to determine where the greatest potential payoffs will be.

A more detailed analysis of specific 'policy sensitive maintenance' actions will follow serving as the basis for the development of a maintenance management system. The developed system will be tested and alternative maintenance policies re-evaluated. The study will conclude with a recommended maintenance management system to achieve a most cost-effective ship maintenance policy.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0263, PASSIVE BUOYANCY SYSTEMS

L.G. HALL, North Amer. Rockwell Corp. , *Long Beach, California* 90803

Efficient buoyancy systems are being sought to fulfill the performance requirements of submerged manned and unmanned vehicles, structures, and equipment. Preliminary studies have indicated that buoyancy materials of 31 lbs. per cubic foot (pcf) are feasible. A research program conducted by Ocean Systems Operations of North American Rockwell was directed at achieving a development goal of a 34 pcf buoyancy material. The research effort determined that it was feasible to make syntactic foam of 40 pcf or less meeting preliminary test requirements for depths to 20,000 feet. The feasibility of casting multiple 3 inch O.D. pyrex spheres in an array with accurate juxtaposition in a syntactic foam matrix was also demonstrated. A hexangonal prism with a density of 34 pcf was achieved and survived tests at 17,000 psi. Accurate positioning of high-strength macrospheres encapsulated in syntactic foam required special manufacturing techniques. During the research program emphasis was placed on the process and producibility factors which would provide good quality control. The results of the research are presented in an internal technical report, 'Development of a Passive Buoyancy System for 20,000 Foot Depth,' T8-744/020, April 1968, prepared by L.G. Hall and A.R. Quinn.

SUPPORTED BY North American Rockwell Corporation

8.0264, DEEP SUBMERGENCE VEHICLES - DYNAMIC ANALYSES

A.D. NEWSHAM, North Amer. Rockwell Corp. , *Long Beach, California* 90803

This research project concerned the definition and development of the testing and data acquisition techniques necessary to obtain accurate hydrodynamic data on marine class bodies -- as well as the subsequent incorporation of these results into dynamic analyses of vehicle motion. Experimental air/water tests were conducted to define hydrodynamic parameters, and the resulting data was combined with theoretical analysis to define vehicle characteristics. This data was prepared in format suitable for guide retrieval and use with analytical tools for vehicle and system design. Project milestones included vehicle mathematical models, synthesis of hydrodynamic data, rotation testing, superposition testing, free surface operation, added mass estimation and hull-interference on toil surfaces. A significant portion of relevant data was acquired from test programs concerning North American Rockwell's Beaver Mk IV submersible work/research boat.

SUPPORTED BY North American Rockwell Corporation

8.0265, RESEARCH SUBMARINE BEAVER MK IV

G. TUTTLE, North Amer. Rockwell Corp. , *Long Beach, California* 90803

A program of applied research was conducted in support of the developemnt of North American Rockwell's Beaver MK IV Submarine Work Boat. The research was directed at achieving advances in a number of specific technological and operational areas, which included: Integrated Control and Display System; Manipulator Systems; Underwater Construction Tools; Components and Subsystems.

The results of this research were directly applied to the development of advanced, high performance systems for utilization in a high pressure marine environment. Extensive laboratory and field tests were conducted on samples and prototypes of candidate units to establish high degrees of reliability and confidence in those systems and components being incorporated into the Beaver IV. Beaver MK IV, a manned work/research submarine is to be launched in Septempber 1968. Beaver is an on-site vehicle designed to perform a wide variety of undersea work assignments. Vehicle capabilities include diver lock-out potential down to 1000 feet and dry test bed in undersea systems development experimental and test programs.

SUPPORTED BY North American Rockwell Corporation

8.0266, WAVE UPLIFT FORCES ON HORIZONTAL PLATFORMS

F. RAICHLEN, Calif. Inst. of Technology, Graduate School, *Pasadena, California* 91109

The underside of a platform intersecting the crests of a train of water waves is exposed to high transient pressures. The specific objective of this research is to study theoretically and experimentally the pressure distribution and resultant forces associated with these transient pressures.

A more detailed fundamental approach is necessary in order to gain a better understanding of the relationship between the characteristics of the incident wave and the resulting pressure distribution when a finite plane surface intersects the wave crests. It is the primary objective of this research to deal with this basic problem with attention being given to the relation between the detailed structure of the pressure distribution and the details of the causative waves.

SUPPORTED BY U.S. National Science Foundation

8.0267, DEEP RECOVERY SYSTEM

R.K. HELLER, U.S. Navy, Undersea Warfare Center, *Pasadena, California* 91107

Objective: Provide a capability for unmanned underwater location and recovery of objects from the sea floor. Recovery is important in studying performance and in the case of malfunction for determining requirements for design modifications and/or operational usage. This capability can have additional important uses such as inspection and surveys of underwater equipment. An ultimate operating depth capability of 20,000 ft is required. The immediate goal is a depth capability of 7000 ft to be achieved during the second quarter of FY 70.

Approach: The Naval Undersea Warfare Center has developed the cable-controlled underwater recovery vehicle (CURV), the present model of which has a depth capability of 2500 ft. This project provides for the development of the technology required for extending the depth capability of unmanned systems. The actual construction of such advanced equipment is funded by other sources. Achievement of increased operating depth requires development of improved television viewing systems, acoustic detection systems, remote handling equipment, and propulsion units capable of operating at the enormous pressures existing at the ocean depth. Noncollapsible buoyance materials are a special need. Transmission of electrical power, and command and control signals from the support ship, via the lengthy cable, to the under vehicle, for example, requires an advancement in technology. Specialized navigational devices are required to determine the CURV vehicle's position on the bottom with respect to the support ship. These technological problems must be solved to provide the design criteria for construction of advanced CURV vehicles.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0268, TELEMETERING BUOY SYSTEM FOR OCEANOGRAPHIC RESEARCH AND ENIVRONMENTAL PREDICTION

R.F. DEVEREUX, General Dynamics Corporation, *San Diego, California* (NONR)

This task covers the development and deployment of a long range telemetering oceanographic buoy system for use in the Navy's basic oceanographic research program. The development of this buoy is of great importance to the Navy for use in its programs of oceanographic research and in the development of future environmental prediction systems. It will undoubtedly influence the development of future detection and weapon systems and the design of a national buoy system.

This effort involves further engineering development and field operation of two long range telemetering ocean buoys for use in oceanographic research. Work includes continued evaluation of entire buoy system, including meteorological and oceanographic sensors, mooring lines, buoy electronics, mobile data center, and buoy-to-shore radio communication. Convair will coordinate with SIO in exploratory deployment of buoys in N. Pacific. This task will provide for buoy handling and servicing at sea. During the year's deployment, a mobile data center will be operated by Convair to receive data by telemetry from buoys, record and scale data, perform limited data processing and disseminate these data to agreed research and operational users.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0269, OCEANOGRAPHIC ENGINEERING

J.D. FRAUTSCHY, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038 (NONR)

The objective is to develop designs as well as advise on and supervise construction and testing of oceanographic ships, devices and techniques to meet the advancing needs for oceanographic platforms and equipment. During the coming year, representation will be provided for the Navy during construction of AGOR-14 and AGOR-15. Studies on oceanographic vessel design will continue with emphasis upon the development of the boat truck concept.

Results from this task are expected to significantly contribute to the design of oceanographic research ships in the Navy Ship Construction Program, including those used by Navy in-house and contractor laboratories. The bathythermograph digitizer will accelerate the handling of BT slide and should reduce the backlog of unprocessed slides.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0270, DEEP OCEAN ENGINEERING TECHNOLOGY

F.N. SPIESS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (N00014-67-A-0109-0008)

Increased national and Navy interest in the ocean from military scientific and economic considerations has stimulated investigations toward development of technological and engineering capabilities to work in the deep ocean environment. The objective of this work unit is to contribute toward development of such technology as it is applicable to Navy-oriented efforts.

The Benthic Laboratory will be installed in approximately 1200 feet of water 3 miles off-shore in La Jolla Canyon. It will be used in conjunction with precisely positioned sensor fields to be installed on the ocean floor. Development of the new high-dexterity tensor manipulator for use in Benthic Laboratory will continue. RUM experiments will be conducted from the new Ocean Research Buoy (ORB).

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0271, SHIPBUILDING COST ESTIMATING METHODOLOGY

UNKNOWN, Engineering & Mgt. Sci. Corp. , *Woodland Hills, California*

PURPOSE: To develop techniques that will enable more accurate forecasts to be made of the economic effects of introducing innovations in shipyard facilities, ship design, and quantity procurement.

DESCRIPTION: This study will identify significant differences between past practice and improved shipbuilding methods, and their effect on shipbuilding costs. It will show where, and to what degree, conventional 'system oriented' cost estimating records and methods do not fully reflect these differences. A 'product oriented' method of recording costs and analyzing data will be developed to more effectively take into account the effect of innovations.

The approach treats all structure, piping, ducts, and wiring located in a given assembly module as a unified product, and makes specific allowance for the working environment. The innovations considered are the facilities, design techniques, etc., which permit fabrication and outfitting to be done under convenient and efficient shop conditions as contrasted to conditions on the ship.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0272, HUMAN FACTORS IN SHIP CONTROL

UNKNOWN, General Dynamics Corporation, *Groton, Connecticut*

Purpose: To develop guidelines for determining human factors involved in bridge control for use in improving bridge equipment and arrangement.

Description: Guidelines are being developed for use by ship bridge designers to achieve an effective application of space and equipment to the deck officer's tasks in ship conning and control. Emphasis is placed upon the frequency and criticality of tasks, information requirements, human capabilities and stresses encountered by the bridge watch in arriving at and executing decisions.

Controls, displays and layouts resulting from analysis of these factors have been described as a means of assisting human performance. Criteria for equipment and layout design which would minimize human error have been developed and demonstrated in three alternative bridge designs, two of which were selected for tests and evaluation. Full scale models of these designs are presently under construction after which measures of operational and cost effectiveness will be obtained.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0273, CATAMARAN CONTAINERSHIP FEASIBILITY

UNKNOWN, General Dynamics Corporation, *Groton, Connecticut*

PURPOSE: To determine the technical and economic feasibility of utilizing twin-hulled ships for transocean shipment of unitized cargo.

DESCRIPTION: The general configuration of a twin-hulled vessel provides a large deck area for the stowage and rapid handling of containers. In addition, the catamaran offers much improved vessel stability in rough water, and an opportunity for higher overall ship speed.

Initial research included a literature search and state-of-the-art digest; and a parametric analysis that evaluated such items as speed, power, size, cargo carrying capability, and structural material. This analysis has been carried out with the use of a computer program for ships that range in speed from 18 - 28 knots and carrying capacity from 10,000-30,000 DWT, built of both steel and aluminum.

Economic trade offs are being made between steel and aluminum structural materials. Models are being towed in the test basin at MIT to determine the resistance and interaction of waves between the two hulls, and are being evaluated for their sea keeping capabilities.

The final element of the feasibility study will be three conceptual designs and an economic analysis.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0274, ADVANCED NUCLEAR CARGO SHIP

UNKNOWN, General Dynamics Corporation, *Groton, Connecticut*

PURPOSE: To develop a preliminary design, construction features and associated total cost analysis of a representative large, high speed advanced nuclear powered cargo ship which can accommodate the latest Maritime reactor systems presently offered.

DESCRIPTION: A single standard 100,000 SHP machinery plant has been designed which is adaptable to any of the 'loop type' or 'integral' reactor designs now offered on a fixed price, guaranteed performance basis.

The nuclear ship design reflects a high degree of reliability, maintainability and automation. All equipment is specified to function for a minimum of 5 years of continuous operation without repair. Machinery layout is such that all components are easily accessible for maintainence and testing. Advances in centralized control and automation have been included to make it possible to operate the ship with a crew of 40 as opposed to the 66 man crew presently required on the SAVANNAH.

Improvements have been made in shield design which utilize concrete to a large extent and reduce both shielding weight and cost.

The large 30 knot nuclear ship is being studied in an economic environment as a system of three containerships operating between the U.S. East Coast and the Far East.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0275, DIGEST OF THE ADVANCED NUCLEAR CARGO SHIP STUDY

UNKNOWN, General Dynamics Corporation, *Groton, Connecticut*

Under this study a preliminary design, construction features and associated total cost analysis was prepared for a hypothetical, large, high speed, nuclear powered, high productivity containership operating on Trade Route 12.

The study is based on currently available proven technology and hardware that can be offered by United States industry on a fixed price/warranty basis, with particular emphasis on pre-assurance of operational dependability. The machinery space was arranged to accommodate all combinations or maritime reactors and propulsion machinery presently offered in the 100,000 SHP range. A single standard machinery plant was developed which is adaptable to either the 'loop type' or 'integral' reactor designs.

The ship design reflects a high degree of reliability, maintainability and automation. All equipment is designed for a minimum of 5 years continuous operation without repair. Machinery layout is such that all equipment is easily accessible for maintainence and testing. The report finds that advances in centralized control and automation make it possible to operate the advanced nuclear ship with a crew of 40 as opposed to the 66 man crew presently required on the N. S. SAVANNAH; and that improvements have been made in shield design since SAVANNAH which utilize concrete to a large extent and reduce both shielding weight and cost.

The report PB No. 178-964 is available from the Federal Clearinghouse for Scientific and Technical Information, Springfield, Virginia, 22151.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0276, WATER-TO-AIR RETRIEVAL

I.R. SMITH, All American Engineering Co. , *Wilmington, Delaware*

This project was a preliminary study of a method using fixed wing aircraft to recover packages from a water surface. It involved study of the design, analysis, fabrication, and testing of a balloon type water pick-up station for use with 1,000 pound recoverable objects.

As envisioned by All American, the pick-up station consisted of a recoverable package, floating on the surface of the water, connected by rope to a balloon. The aircraft was to fly by, engage the rope at a point just below the balloon, and winch the package aboard. The basic recovery system, including the winch, been developed and tested by All American, and could be adapted for over the water recovery.

A mathematical model was used to establish the basic parameters on the 1,000 pound recovery station. The input parameters included a load limit on the package, rate of climb of the package and speed of the aircraft. From the model, the minimum length and strength of the rope for the pick-up station were found.

In this type of recovery system it is important that the balloon keep the pick-up lines as nearly vertical as possible. Various balloon shapes were studied to determine the one which would function best in winds of 15 to 20 knots.

SUPPORTED BY All American Engineering Company

8.0277, A STUDY OF A TRANSITIONAL CONTAINERSHIP CONCEPT

A.R. GOOBECK, U.S. Dept. of Commerce, Maritime Administration, *Washington, District of Columbia* 20235

This research study developed a ship design that features a hold module and cargo handling system arranged to facilitate ready changeover from a highly flexible (100%) breakbulk operation to efficient all container stowage via cellular stacking without the need for extensive structural modifications, guide installations, or additional handling equipment. Such ships can be used in the 'uncertain' trades to help smooth the transition from breakbulk cargos to containerized cargo.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0278, PRELIMINARY CALCULATION OF THE LIFT AND DRAG AND ANGLE OF ATTACK FOR SUBMERGED HYDROFOILS

J.G. GROSS, U.S. Dept. of Commerce, Maritime Administration, *Washington, District of Columbia* 20235

A hydrofoil lift and drag calculation procedure has been computerized in such a way as to minimize data input requirements. The goal was to develop a relatively simple method for determining hydrofoil lift, drag and foil angular motion at various speeds. The twenty-nine model input items include foil physical characteristics such as span, area, chord, dihedral, sweep, end plate height and distance, thickness, and camber; nacelle characteristics such as length, location on strut, diameter, projected area; and system characteristics such as craft weight, submergence, design speed, and flap or incidence control indicator. Model output includes downwash drag, included drag, parasite drag, total drag, foil angle, no lift angle and flap angle.

All of the output is varied from the take off speed (foilborne transition) to the maximum design speed in small speed increments.

The model is written in FORTRAN IV for H200. As yet, no model operating documentation exists.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0279, MODEL FOR THE PRELIMINARY DESIGN OF SURFACE EFFECT SHIPS

J.G. GROSS, U.S. Dept. of Commerce, Maritime Administration, *Washington, District of Columbia* 20235

This computerized model performs a preliminary analysis of surface effect ship types. The goal was to determine major characteristics of surface effect ships for further analysis in a commercial environment. The model input includes such variables as vehicle gross weight, vehicle surface clearance, cushion loading parameter, number of compressors, significant wave height in a seaway, vehicle design range, design speed, beam/length ratio, vehicle body aero lift coefficient, and body aero drag coefficient.

Consideration is given to the various drag components, propulsion efficiency by various devices, compressor requirements, sea wave height effects, and vehicle weight components.

Model output is presented as vehicle physical configuration, normalized drag components variation with vehicle speed, normalized propulsion and cushion fan power requirements with speed, cushion and propulsion power weight variations with speed, maximum power and design, structural weight, propulsion and cushion machinery weight, equipment weight, fuel requirements, and payload capacity.

The model is written in FORTRAN IV for H200. As yet, no model operating documentation exists.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0280, ADVANCED RESEARCH - SATELLITE INTERROGATED ENVIRONMENTAL BUOY

J. HUSON, U.S. Dept. of Commerce, Off. of Systems Engin. , *Washington, District of Columbia*

Objective - Design, develop and test low cost buoy systems for sea keeping and satellite interrogation characteristics.

Approach - Test three buoys for: 1. Sea keeping characteristics 2. Communication with NASA ATS-C synchronous satellites.

Preliminary studies, designs, and testing of half scale models completed as in-house efforts. Three full scale buoys to be fabricated in accordance with detail design specifications. Tests to be conducted in coordination with interested ESSA divisions.

Progress (to June 30, 1967): Program funds became available in July 1966 and specifications for development of three prototype buoys were completed. The RFP was issued in December 1966 and proposals evaluated which resulted in selection of Ocean Research Equipment, Inc., of Falmouth, Massachusetts, as the contractor. The contract was signed in April 1967.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

8.0281, NATIONAL DATA BUOY STUDY

R.W. GOEHRING, U.S. Dept. of Transportation, Coast Guard, *Washington, District of Columbia* 20591

This amount represents the National Science Foundations portion for the support of the National Data Buoy Study conducted by the U. S. Coast Guard as per agreement between Dr. Leland J. Haworth, Director, National Science Foundation and Dr. Robert A. Frosch, Assistant Secretary of the Navy, dated August 17, 1967.

SUPPORTED BY U.S. National Science Foundation

8.0282, ADVANCED DEEP OCEAN TECHNOLOGY

G. SORKIN, U.S. Navy, Ship Systems Command, *Washington, District of Columbia* 20360

Objective: Ascertain through systems analysis, studies and testing the operational depth limitations of present systems and to develop realistic programs and plans for advancing these present systems to meet the ever increasing fleet demands.

Approach: Develop detailed working plans for the development of such deep submergence machinery and equipment as speed reducers, submersible electric drive systems, hydraulic systems, high pressure sea water pump systems and tandem propulsion systems. To develop a detailed working plan requires: precise determination of the state-of- the-art of components which will be required to make up the system, analysis of the requirements of the system as compared to the state- of-the-art, identification of problems of potential problems, and the assembly of a program which includes the above.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0283, STRUCTURAL DESIGN CRITERIA

UNKNOWN, U.S. Ship Structure Committee, *Washington, District of Columbia*

Purpose: To develop means to obtain greater safety without adversely effecting economy.

Description: This program is a joint venture between the Maritime Administration, Navy, Coast Guard, and the American Bureau of shipping.

It has resulted in ship structure improvement which include: finding the cure for brittle fracture problems; elimination of the need for riveted crack arrestors; development of better welding techniques; a better understanding of notch effects; and development of improved radiographic and ultrasonic testing methods. Research is now being performed under the broad headings of Structural Response, Structural Design, and Materials which is expected to lead to further significant improvements by acquisition and analyses of new data; refinement of design and fabrication tools, and establishment of improved design criteria. Significant areas under these headings are: accumulation of data on ship response to seaway conditions (including slamming); statistical analyses of seaway and ship response data; expansion of the use of computers in design; development of hull girder models; determination of the characteristics of high strength steel structures in a marine environment; development of improved acceptance tests for joined materials, and improvement of fabrication methods.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0284, DESIGN AND CONSTRUCTION OF BARGE AND CLAM DREDGE FOR SURVEY OF FLORIDA'S COMMERCIAL CLAMS

H.W. SIMS, State Board of Conservation, *Saint Petersburg, Florida*

Phase 1. During phase one the principal investigator will work with a designer and boat builder to draw plans and construct the barge needed to begin the survey. The actual building of the barge will be done by the ship yard, but will require supervision and communication with the principal investigator. It will be the duty of the principal investigator to find and purchase equipment needed to outfit the boat and to see that this equipment is delivered to the builder in time to meet with the work schedule.

Phase 2. The deeper waters 5-10 feet, along the shore line will be surveyed for hard clam beds. Samples will be taken by running the shore line to the extreme depth, then parallel to the shore at this depth for approximately 100 feet, return to the shore (water depth 3- 5 feet), run parallel for 100 feet, turn and run out to extreme depth. At the end of each run, before turning offshore again, measurements of the clams will be made and data recorded. In most cases the clams will be returned to the water in the same area where they were found. Certain areas may be resampled to gather growth information.

Phase 3. Past studies indicate that populations of the surf clam may be found in large numbers in the mouths of large inlets into the bays. The dredge will be run over these areas to learn the extent of these clam beds. If this clam appears to be available in sufficient numbers, samples collected will be passed on to interested persons in the hope that a market for them may be created. Data, similar to that collected for Mercenaria will be recorded.

Phase 4. Before dredging the area a check of the bottom will be made and data on the abundance, size and condition of both plant and animal species found will be recorded. Samples of the sediments will also be taken and separated for particle size. Upon dredging the area, data will be recorded on the species collected. At some locations checks of the bottom will be made monthly. In other locations checks will be made at 3, 6 and 12 month intervals. These subsequent checks will be made by hand, without the re-use of the dredge. Other areas will be redredged monthly for as long as it is convenient for the dredge to return to the site. Yearly checks will be made of all sites, with the dredge. The data collected should show the immediate effects of the dredge as well as the long range results.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Florida State Government

8.0285, MARINE METEOROLOGY UNTENDED STATION DEVELOPMENT

M. GARSTANG, Florida State University, Graduate School, *Tallahassee, Florida* 32306

Development of a buoy stable enough to perform as a platform for measurements of wind profile in the open sea and development of an instrumentation system for five days of untended operation to measure, digitize and record wind and air temperature profiles, humidity, rainfall, and water temperature.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

8.0286, EXPLORE FISHERY AND RESEARCH APPLICATIONS OF SUBMARINES

R.S. SHOMURA, U.S. Dept. of Interior, Biological Laboratory, *Honolulu, Hawaii* 96812

By correspondence, interviews, etc., the research applications of a submarine are being explored, and the several possible research missions are being related to a variety of broad design possibilities. With the submarine's missions clearly established and ranked in order of importance, a contract will be awarded for feasibility and conceptual design studies. These studies involve optimization of vessel design with respect to size, shape, power, speed and maneuverability; preparation of layout drawings; estimation of costs and schedules for ensuing design, construction, and opeating phases; and a personnel analysis for the operating vessel.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0287, STABLE OCEANIC STATION

R.J. PIERCE, Hydro Space Systems Corp. , *Cedar Rapids, Iowa* 52402

Theoretical and experimental work has been conducted for the past five years on a concept of a large stable submerged oceanic station (100-20,000 tons displacement). The concept under study is based on the principle that a high degree of pitch stability and heave stability can be achieved if the sea station is, for the most part, submerged unaffected by surface conditions of winds and waves. The buoyancy and mass of the submerged portion is made very large. The superstructure protruding above the surface is made very small so that it has minimum coupling to the forces of winds and waves. The magnitude of the lateral forces of winds and waves is very small compared to the vertical forces of the large submerged mass, thus achieving a high degree of pitch stability. Pitch stability is further enhanced concentrating the buoyance and mass structures laterally and widely separating the center of buoyancy and the center of mass. The buoyancy chamber and mass chambers are discus-shaped to minimize drag due to ocean currents. Since dynamic station keeping is contemplated, low drag is important to minimize propulsion power. Analysis and scale model tests of large ocean stations of the order of 20,000 tons indicate that pitch stability of less than plus or minus 1 degree in 60-foot waves and 100-knot winds can be achieved. Analytical and scale model testing under simulated ocean conditions are being continued by Hydro-Space and the Hydraulics Institute of the University of Iowa. It is anticipated that when developed, the stations could be used for many applications, such as deep ocean radio data stations, deep ocean communication and navigation stations, offshore oil production rigs, and general sea bases for other applications. One specific application is shown in the SEACOM brochure attached.

SUPPORTED BY Hydro - Space Systems Corporation

8.0288, DESIGN STUDY - AN OPTIMUM FISHING VESSEL FOR THE GEORGES BANK GROUNDFISH FISHERY

C. HAMLIN, Ocean Research Corporation, *Kennebunk, Maine* 04043

This study was initiated to devise a method of optimizing fishing vessel design and operation for any fishery. Optimality was defined as maximum Return on Investment (ROI), and the Boston, Mass., fishing fleet was selected as the foundation. A generalized functional model of fishery resource exploitation was constructed. From this, a mathematical model was prepared, based on the Georges Bank groundfish fishery, and programmed for an IBM 1130 computer, the output being ranked according to RIO. The model related vessel characteristics, crew size, and fishing operations, to the basic elements of the fish harvesting system, i.e. the net/engine/propeller subsystem. Descriptive plans were prepared for the resulting optimum vessel: LOA - 125', shaft HP - 1030, crew size - 16. Predicted maximum return on investment for the optimum vessel was 26.7%. The study demonstrates the feasibility of using a suitable computer program to examine the highly complex fishing operation, and to optimize any desired subsystem.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0289, PROPULSION EFFICIENCY 'U' VERSUS 'V' STERNS

UNKNOWN, U.S. Navy, Ship Research & Dev. Center, *Caderock-washington, Maryland* 20007

DESCRIPTION: Using a Series 60 - .60 block coefficient model with normal stern configuration as parent for the tests, two mathematical forms were derived maintaining the same sectional area curve as the parent, such that one was more 'V' and the other more 'U'

21.3' level keel design draft.

Wake survey tests were made with all three hulls at the 21.3' draft. In addition tests were made with the parent model at 80% design draft at both level keel and trim by the stern - the trim by the stern being such that propellar immersion was equal to that at design draft.

The tests were made at the equivalent full scale speed of 19.5 knots, 12.75 knots and 6.0 knots for the parent form and at 19.5 knots only for the other two.

The next stage will be to perform vibration tests and make comparison with existing NSRDC propulsive data to determine the relative roles of wake distribution and vibration on over-all propulsive efficiency.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

8.0290, CONTRAROTATING PROPELLER IN JUMBOIZED MARINER

UNKNOWN, U.S. Navy, Ship Research & Dev. Center, *Caderock-washington, Maryland* 20007

Purpose: To investigate the feasibility of converting existing mariners into containerships by jumboizing and in addition utilizing contrarotating propellers.

Description: An existing mariner model was lengthened by adding parallel midbody, representing 95 feet full scale, and fitted with a stock contrarotating propeller; in order to fit the propeller, the aft end of the existing shaft bossing was cut off an amount corresponding to two feet full scale.

The model was run for EHP and SHP at a displacement of 18,840 tons at 21.38 mean draft. These tests will be compared with tests of the original shorter model running at 18,610 tons at 29.96 feet draft with normal single screw propeller.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

8.0291, SHIP DESIGN WAVE RESEARCH

R. ZARNICK, U.S. Navy, Ship Research & Dev. Center, *Caderock-washington, Maryland* 20007

Objective: To conduct oceanographic research in those areas specifically affecting the design, development and operations of ships. Provide a centralized source of oceanographic knowledge and improve existing oceanographic data used in ship design.

Approach: To simulate true sea state in model hull test facilities. A continuing study will be made of oceanographic literature to keep abreast of the most recent theories as to the most suitable representation of the seaway and all significant advances will be immediately applied to the ship design problem. Techniques will be developed for the generation of directional wave spectra in the Model Basin's Seakeeping Facility (MASK) to provide for a more meaningful model of oceanographic environmental conditions. The Model Basin will use its technical abilities to assist the oceanographer in obtaining reliable measurements of ocean environmental conditions.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0292, DEEP SEA SUBMERSIBLES

K.G. PICHA, Univ. of Massachusetts, School of Engineering, *Amherst, Massachusetts* 01003 (N00014-67-A-0158-0005)

Objective: The objective of this program is to develop, through a center of excellence, a body of knowledge in the field of deep sea engineering, particularly for exploration and exploitation devices. The interdisciplinary research program is broken into the following areas of immediate technological concern; energy conversion, environment, guidance and control, hydrodynamics, materials, propulsion, and structures.

Approach: The investigators will continue theoretical and experimental work on (a) streaming of water by interaction with magnetically accelerated colloids, (b) composite materials (c) deep submergence vehicle system design (d) nonlinear behavior of hull structures (e) impact leading of submarine hulls (f) effects of pneumatic and hydraulic breakwater devices (g) design criteria for underwater anchorages (h) kinetics of ebullient bed catalytic reactions (i) aerodynamic simulation tests for marine vehicle components (j) propeller and wake noise in deep sea submersibles.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0293, STEP RESPONSE METHOD FOR DETERMINING HORIZONTAL COEFFICENT FOR DEEP SUBMERSIBLES

M.A. ABKOWITZ, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Massachusetts Institute of Technology

8.0294, A STUDY OF THE INTERFACE LOCATIONS BETWEEN DISSIMILAR MATERIALS AND OTHER ASPECTS OF A COMPOSITE MIDSHIP SECTION

L. AFANASIEFF, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

The following aspects of midship section design, with employment of different component materials, are analysed: the stress schedule and optimum neutral axis position, the interface locations between dissimilar materials, the relation between frame and longitudinal spacing and their influence on the hull plating thickness, the ultimate strength of the composite hull girder and some aspects of a computer approach to composite midship section design.

SUPPORTED BY Massachusetts Institute of Technology

8.0295, WEIGHT ANALYSIS IN FISHING BOATS

R.W. CANAR, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

The purpose of this study is to determine a method for estimating the hull steel weight in the early stages of the design.

Hull steel weight refers only to the underdeck weight less the weight of bulkheads, deckhouses, and foundations.

Since the hull steel weight is a direct function of the ship's full length scantlings and at the same time these are a direct function of the midship section scantlings, most of the work was devoted to find a relationship, if any, between the weight of the midship section and the hull steel weight.

The weight of the midship section used is the 'weight per foot' which is the weight per foot of the longitudinal members plus the weight of the transverse members in one frame space divided by the frame spacing.

A dimensionless coefficient results from the relationship among the hull steel weight, the weight per foot of the midship section and the ship's length P equal W sub n/W.L where W sub n equals hull steel weight (lbs); W equals weight per foot of the midship section (lbs/ft); L equals length (ft).

To take care of the variation of scantlings toward the ends, this coefficient was related to the form prismatic coefficient C sub p.

Since the scantlings are proportional to the local radius in each station, the value of the 'Weight prismatic coefficient' alpha sub p and C sub p was expected to be the same. The results showed that it is not so for the following reasons: 1. There is much steel which is not shown in the midship section. 2. Both the block and prismatic coefficients used in this analysis were those calculated up to the design water line and these always less than the ones calculated up to the full depth.

The way chosen to include the effect of the vessel's size is the cubic number of times the block coefficient (I.B.D.C sub b/100) which is a rough measure of the underdeck volume.

SUPPORTED BY Massachusetts Institute of Technology

8.0296, AN INVESTIGATION OF THE PERFORMANCE OF A COLUMN STABILIZED PLATFORM

K.A. GUSTAFSON, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

The objective of this thesis is to obtain a comparative analysis of various combinations of column configurations for a mobile column stabilized platform. The platform is a deep draft vessel consisting of two longitudinally oriented, cylindrical hulls. To each hull two vertical colums are attached which pierce the surface of the water. The upper ends of the columns are attached to a platform well above the waterline. The platform may provide added performance capabilities in comparison with a standard displacement vessel. The mobile column stabilized platform is not without its problems, however, and this experimental and analytical study provides an analysis of some of these problems.

The resistance characteristics were studied with the use of a model in the M.I.T. Department of Naval Architecture and Marine Engineering Ship Model Towing Tank. A correlation of the data with theory was attempted to obtain interference resistance between the columns. The effect of transverse and longitudinal spacing of the columns, draft, and shape of the columns was investigated and correlation with theory was attempted. The results indicated the parameters of longitudinal spacing and velocity have the most significant effect on interference resistance.

The resistance characteristics of the model are compared with a standard hull form. The constraints imposed by stability and strength requirements on the column shape and size are theoretically calculated.

SUPPORTED BY Massachusetts Institute of Technology

8.0297, OPTIMIZATION METHODS APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL AUXILIARY

F.C. HOLMES, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

The technique for optimizing multidimensional functions developed in Refs. (7), (10), and (13) has been applied in this report to the preliminary design of a multimission naval auxiliary. The algorithm computes a number of effectiveness factors for each design which reflect the ship's ability to meet its specified mission requirements. factors are then combined with the ship's twenty-five year life cycle costs in an optimization criterion which permits selection of an optimum design. Sample results obtained from the algorithm described in this report are tabulated in Tables III, IV, V, and VI.

Unfortunately, the optimization technique utilized in this report did not permit examination of results in terms of the effect on cost of each individual effectiveness factor. For this reason, the recommendation is made that for future studies of this kind, an entirely new approach should be taken as described in Section IV.

SUPPORTED BY Massachusetts Institute of Technology

8.0298, EFFECTS OF MATERIAL VARIATIONS IN THE COMPUTERIZED DESIGN OF PRIMARY HULL STRUCTURE

J.F. INCE, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139

The fifth of a series of computer programs has been developed to design the longitudinally continuous and primary transverse members of a ship's midship section. Any framing system and material distribution may be chosen for a given geometry and a normalized weight and cost will be determined. Using three types of steels, optimum combinations are found by a parametric study and a 'performance norm' solution of weight vs. cost obtained.

This curve is then used as a reference against which to test the suitability of other materials, such as titanium. Also, materials with hypothetical strength properties are investigated to show under what circumstances, i.e. for what unit weight and cost, they might excel the three commonly used steels used in optimum combinations.

SUPPORTED BY Massachusetts Institute of Technology

8.0299, THE INVERSE PROBLEM IN PROPELLER DESIGN

P.C. MAKRIS, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

A computational method is presented by which the performance of a propeller operating at conditions different than the design conditions, can be determined.

The analysis presented makes use of existing computational methods for the solution of the direct or design problem.

A computer program is developed and the results compared with experimental data. This comparison is considered favorable.

SUPPORTED BY Massachusetts Institute of Technology

8.0300, INVESTIGATION OF NAVAL SHIP FORMS

P. MANDEL, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Massachusetts Institute of Technology

8.0301, CONTROL OF SUPERCONDUCTING MACHINES FOR SHIP PROPULSION

L.S. MATJASKO, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

It is known that superconducting machines of capacity large enough to power ships of a destroyer's size are within the capability of present technology. Given this fact, the control of these machines must be examined to the extent of determining ship performance realizable with such a drive system.

A mathematical model for ship-propulsion plant performance is derived using the propeller characteristics of Nordstrom (14). From the model, a set of ideal performance characteristics in the form of plots of stop to full ahead and crash astern transients is obtained. These do not account for any equipment, prime mover, or machine limitations.

A conceptual design of a control system is presented. The system accounts for limitations on ideal performance that are discussed. Feasibility of the system is demonstrated.

Finally, incorporating the limitations to ideal performance, the model and control system are used to predict realistic ship performance characteristics, assuming power plants of gas turbines and conventional steam.

The principal results are that the gas turbine plant provides faster response to demands for increasing speed and that neither plant provides an advantage in a crash astern maneuver.

The characteristic plots for the transient maneuvers provide a basis of comparison for the observer familiar with capabilities of other power plant, control, and drive system combinations.

SUPPORTED BY Massachusetts Institute of Technology

8.0302, A DUAL MODE ROLE STABILIZATION SYSTEM

F.J. RICHMOND, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

The Deep Submergence Rescue Vehicle is being built with an activated roll stabilization system. The effectiveness of this system is limited by pump saturation. This investigation is concerned with improving the roll stabilization of the DSRV through the use of a passive tank stabilizer. A mathematical model for the tank system is developed and adapted to the DSRV model. The passive system is extended to include two modes of operation, each representing a separate tank frequency, which may be selected by the operation of a valve. The passive system and the dual mode system are simluated on an analog computer to determine their response to transient disturbances.

The results show that a passive stabilizer of reasonable design could improve the roll stabilization of the vehicle. Furthermore, it is concluded that stabilization of transient disturbances can be improved by dual mode operation if a tank frequency at least three times greater than the natural frequency of the vehicle can be obtained for one of the two tank modes.

SUPPORTED BY Massachusetts Institute of Technology

8.0303, ESTIMATION OF HULL STEEL WEIGHTS FROM MIDSHIP SECTION CHARACTERISTICS

J.W. ROYLE, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

The purpose of this thesis is to develop a refined method of estimating the hull steel weights of naval auxiliaries. The approach utilized is based on the primary structure exhibited amidships, with modifications to account for partial substructures.

The primary structure includes the shell and framing, and decks, inner bottom, and longitudinal bulkheads whenever they are continuous for substantially the full length of the ship. Based on this primary structure at amidships, a 'normalized weight,' or weight per foot of longitudinally continuous material, plus the weight of transverse members divided by their spacings in feet is determined.

On the basis of the research discussed in Part II of this thesis, there is a strong indication that the normalized weight may be predicted by considering various properties of the midship section in longitudinal bending and specifying the allowable bending stress.

The normalized weight is used to predict a 'standardized underdeck weight' by means of an 'adjusted weight coefficient.' The standardized underdeck weight includes the weight of those items which are included in the normalized weight plus some smaller items (see Part I, section B) which are felt to be related to ship size. The adjusted weight coefficient relates the normalized and standardized underdeck weights.

Weights of partial substructures and special features must be added to the standardized underdeck weight to obtain the total underdeck weight. The special features are items which are not expected to show any trends in relation to ship parameters or which are unique to a particular design or ship class. These must be handled separately and individually. The partial substructures of greatest concern are transverse and local longitudinal bulkheads and platforms, flats, and discontinuous decks. Suggested approaches to developing estimation techniques for these items are discussed in Part III, sections A through D. The most interesting indication shown is probably that the curves of sectional areas between the design water line and the uppermost longitudinally continuous deck may be fairly well approximated by 3 straight lines for hulls with vertical sides above the DWL at amidships.

SUPPORTED BY Massachusetts Institute of Technology

8.0304, STRESSES DEVELOPED ON THE SURFACE OF CYLINDRICAL JOINTS SUBJECTED TO MULTIPLE LOADS

J.C. SCHAFF, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

This paper deals with the stresses developed at the intersection of two circular members of different diameters. Both members carried axial loads, with the larger member being continuous through the connection and the smaller terminating at the connection. The method for determination of the stress was by coating the larger member with photoelastic plastic and observing the stresses that developed at the connection. Stress concentration factors were determined by loading the larger member prior to the connecting of the smaller members.

Analytical results, obtained from attempting to predict the moment in the larger member generated by the load on the smaller member, were calculated by using Hovgaard's Continuous Ring Frame Analysis and Hardy Cross's Column Analogy. The circumferential stress from this moment was combined with the axial stress from the large member's end load, and the result modified by the stress concentration factor determined earlier. When the model tests were compared to the analytical results, it was found that the moment or stress predicted was 2.5 to 3.2 times higher than that which would be expected from the model tests. A great deal more investigation must be done with this type of joint before a clear understanding of what is happening within both members will be reached.

SUPPORTED BY Massachusetts Institute of Technology

8.0305, AN EXPERIMENTAL INVESTIGATION OF PARTIALLY SHROUDED POPELLERS

P.T. TARPGAARD, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

Results are reported for a series of experiments in which forces associated with a propeller fitted with a partial shroud are measured. The shroud is partial in the sense that it subtends only 180 degrees of the propeller circumference rather than the full circumference, as is commonly the case. S. J. Gordin in 1966 proposed that such a shroud could be used as a rudder if mounted so that it can be moved from one side to another on the propeller circumference. A difference in velocity between the water moving on each side of the shroud produces a radial force which can be directed to either side by moving the shroud.

The quantities measures were the radial and axial force on the shroud, termed 'lift' and 'drag', and the thrust and torque on the propeller. Measurements were made in a propeller tunnel using a series of four different half shrouds with a single propeller. Variations were made in the geometric properties of the shrouds and in the orientation of the shrouds to the incoming flow with the object of determining the effect of these properties on the behavior of the propeller-shroud combination. Graphs of shroud and propeller performance characteristics are presented and methods of interpreting and comparing them are suggested.

It is found that rather large radial forces can be obtained with partial shrouds while getting very little accompanying drag. Under many operating conditions a thrust will be developed for the shroud. The forces on the shroud were found to be very sensitive to the angle of attack of the shroud and to a lesser extent on the camber of the shroud crossection. The shroud has a marked effect on the propeller characteristics and the results indicate that a higher pitch propeller than would be chosen otherwise might be desirable when using a partial shroud.

The partial shroud as a steering system seems to offer particularly good characteristics for applications where good maneuverability at low speeds is desired such as in tugs or salvage vessels. With more research and design development it might prove superior in a more general range of applications.

SUPPORTED BY Massachusetts Institute of Technology

8.0306, SEAKEEPING QUALITIES - MOTIONS AND POWERING PREDICTIONS

UNKNOWN, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139

Purpose: To devise means to predict the over-all seakeeping qualities of modern merchant vessels during the design stage in order to improve their performance in rough weather.

Description: Computer programs developed by M.I.T. for determining different displacement ship responses to wave actions (i.e., pitching, bending moment, added resistance in waves, etc.) have been consolidated into one master program. 'Still water' resistance data for the Taylor and Series 60 Families have been added to the program. The end product will be a design manual that will enable the naval architect to base his design, not only on still water powering performance, but on powering in a seaway and seakeeping capabilities.

The research also includes a computer program to predict the motions of, and the vertical and horizontal forces in connections between, single line ahead push barge tows. Model tests in head seas with three barges have been made to check the barge computer program. This phase of research is an integral part of an overall barge investigation being conducted both at M.I.T. and Stevens Institute.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0307, OPTIMIZATION METHOD APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL SALVAGE TUG

G.F. WAGNER, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

A non-economic optimization criterion is developed for a multi- mission naval salvage tug in this report. The optimization is carried out on a digital computer by the use of the exponential random search procedure in a multi-dimensional design space. The algorithm minimizes the quotient formed by dividing the life cycle cost of each design by the sum of a number of non-economic effectiveness measures of the design. The effectiveness measures chosen reflect the ability of the tug to meet its required towing mission and salvage mission. Sample results of the program are contained in section III of the paper.

The optimization criterion proved satisfactory, but, the method of computing individual requirement effectivenesses was not satisfactory in all cases. An improved method for computing the effectiveness of a design is recommended in Section V.

SUPPORTED BY Massachusetts Institute of Technology

8.0308, SATELLITE INTERROGATE ENVIRONMENTAL BUOY DEVELOPMENT

D. FRANTZ, Ocean Research Equipment Corp. , *Falmouth, Massachusetts*

TECHNICAL OBJECTIVE: The ocean buoys to be fabricated under this contract are part of a system to measure oceanographic and meteorological parameters at remote sites and transmit the information to a central analysis location through satellite communication relay of data.

Approach; Develop and fabricate three prototype buoys. One buoy will be used to test long life mooring configurations and seakeeping characteristics. Two buoys will be used to test deep ocean moored characteristics, survivability and communication with satellites. The basic contract is amended to include emplacement and testing of Buoy 01.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

8.0309, BUOY ENGINEERING

R.G. WALDEN, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

The objective of this task is to improve the instrumentation necessary to the moored experiments being conducted at Woods Hole. These engineering efforts will include a theoretical and experimental study of the performance of deep ocean mooring lines in the ocean; comparative testing and evaluation of mooring materials, hardware, and fabrication techniques; design and development of surface and subsurface prototype buoys to meet the research requirements; and development and testing of special engineering telemetry system for use in the program.

This work is a necessary adjunct to the efforts of the WHOI scientists to determine the scales of oceanic motion using moored oceanographic buoys. The technology will benefit the Navy, both in its contributions to understanding the physics of motion in the sea and to other buoy systems required by the Navy.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0310, PRESISTANCE AND PROPULSION HUL CONFIGURATION

UNKNOWN, Univ. of Michigan, Graduate School, *Ann Arbor, Michigan*

Purpose: To investigate ways of improving the powering characteristics of U.S. merchant vessels, and solve ship powering problems as they may present themselves in specific ship design cases.

Description: Currently two projects are under way as set out below: Bulbous Bows Model tests with a 0.75 block coefficient form designed at the University of Michigan indicated that a reduction of 10 in power is possible, over a range of from light to full displacement conditions, with the addition of a surface piercing bulb. As a result of these findings investigations of the potential of these bulbs to reduce resistance over a wide range of ship block coefficients are underway.

Additional tests have been made with 0.65 and 0.55 block coefficient models, developed from the initial form by a geometrical method also developed at the University to determine the trend of bulbous bow performance with block coefficient change.

Transom Sterns: It is the objective of this study to carry out research that will provide design information which will allow transom sterns to be utilized by high-speed vessels without power loss.

Resistance and propulstion tests have been completed with seven after body variations, the fore end remaining the same in each case.

Parameters used in the test are: Lenght - 700', beam - 100', draft - 22'-35', block coefficient - 0.50. Stern width has varied from 75' to 45' and stern immersion from 1' to 11.5' over a speed range of 13 to 27 knots.

It is also intended to investigate stepped transom sterns for vessels that at times may have to operate at a much deeper draft than normal load draft.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0311, SATURATED DIVING FACILITIES FOR DIVER-SCIENTIST AND RELATED RESEARCH

G.H. SAVAGE, Univ. of New Hampshire, Graduate School, *Durham, New Hampshire* 03824 (N00014-67-A-0158-0005)

Currently, the feasibility study and model test program for the OSCILAB and SEADOPOD saturated diving facilities are being completed. The EDALHAB will be tested in a lake very soon. Work has started on a compact atmospheric monitoring and control system for saturated diving habitats. Investigation is proceeding of the feasibility of using fluidic controls in undersea vehicles, mobile habitats, and free operating oceanographic instruments.

The work under this contract is directly beneficial to Navy diving, salvage and underwater construction tasks which require saturated diving. Indirectly, it will provide marine scientists with new and improved techniques and tools to procure oceanographic and related data that is of direct Navy concern.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0312, FORCES AND MOTIONS INDUCED BY WAVES ON OCEAN PLATFORMS

J.P. BRESLIN, Stevens Institute of Technol, School of Engineering, *Hoboken, New Jersey* 07030

Stevens Institute of Technology will use the facilities of the Davidson Laboratory for research into the forces and motions induced by waves on ocean platforms with the objective of developing design criteria that will improve design and construction of exploration, trial drilling, and production drilling platforms. Research will be directed to three principal elements: (a) a more precise specification of wave-induced loads on both submerged and projecting surfaces; (b) means of reducing motions induced by the seaway for both moored and dynamically positioned platforms; and (c) determination of wind-induced loads for prediction of overturning moments. The project personnel will adapt to the case of ocean platforms the well-proved Davidson Laboratory program for computing ship motions, supplementing existing information through the use of model elements in the laboratory research tank facilities. A wing tunnel will produce the necessary wind loadings on model elements. Configurations will then be studied to determine how motions can best be reduced at critical frequencies. Results will be presented in a form suitable for use by designers.

SUPPORTED BY U.S. National Science Foundation

8.0313, SHIP MANEUVERING AND CONTROL

UNKNOWN, Stevens Institute of Technol, Graduate School, *Hoboken, New Jersey* 07030

Purpose: To develop a design manual on ship controllability covering determination of rudder shape and area for efficient operation at sea, and improved control during docking and stopping.

Description: Straight run model tests have been made in the regular towing tank; and turning tests conducted under the rotating arm with three Series 60 models of block coefficients 0.60, 0.70 and 0.80, and one mariner model to obtain hull hydrodynamic forces and moments.

Similar tests were made using three different rudder areas. With the aid of the test data, formulae are being developed for estimating the directional stability and controllability of single-screw merchant vessels. Stopping performance tests have also been made and a mathematical model developed to simulate ship stopping maneuvers. This model was checked with available full scale data obtained for an Esso Suez Class tanker. These data will be useful for predicting ship stopping capabilities, and will be put in a form which is useable in ship design.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0314, 40,000 HORSEPOWER PLANETARY REDUCTION GEAR SYSTEM

R. HETTENBACH, Curtiss Wright Corporation, *Rutherford - Wood Ridge, New Jersey*

With the advent of hydrofoil craft and fast deployment logistic ships a need arose for a lightweight transmission system. In one such application, a 40,000 HP gear box was to be installed in a 34 inch pod diameter. Curtiss-Wright through its experience in aircraft planetaries designed, built and has been testing a 4 to 1 planetary system satisfying these requirements. The gear units have an outside diameter of 34 inches, are 5 feet long, weigh 4,000 lbs each and show an efficiency of 99.0 percent. The planetary gear box utilizes double helical gears, journal bearings, aircraft type materials with carburized and ground surfaces. The accuracy of the gear tooth elements falls within the precision classification.

A significant departure from normal planetary design has been in the load distribution among the planets. Here, material deflection characteristics and geometric shapes were calculated to arrive at a uniform load distribution.

The criterion for the gear box was to design for an unlimited life all the gear box elements at power ratings of 50,000 HP and 4,000 RPM input speed.

This program has been sponsored by the Navy since 1962. To date, over 300 hours of locked torque rig testing has been accumulated at powers ranging from 25,000 HP to 50,000 HP with an input speed of 4,000 RPM. Additional testing is planned at the higher HP ranges with lower input RPM to match the current high HP gas turbine engines. Final reports are issued at the completion of a given work statement phase.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0315, HIGH SPEED SHIP PROPULSION

R.B. LEWIS, Curtiss Wright Corporation, *Rutherford - Wood Ridge, New Jersey*

Study high speed ship propulsion. Compute the range performance and thrust power ratio for optimized propulsor configurations and show the sensitivity of installed performance to changes in the important component performance parameters for various propulsion system/high speed craft types.

The equations for performance will be developed for all the various combinations from a common base with identification of terms to show the commonality. Types of craft will include hydrofoil, captured air bubble, planing hulls, and displacement hulls. Types of propulsors will include, propellers, waterjets, and mistjet.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0316, MOORING IMPROVEMENT SYSTEM

UNKNOWN, Frederick R. Harris Inc. , *New York, New York*

PURPOSE: To develop an improved ship mooring system that will permit ships to be secured more rapidly, safely, and economically.

DESCRIPTION: An advanced mooring system is being developed which consists of two major parts; a set of constant tension mooring winches (with controls) and a telescopic mooring arm. The system is designed to permit two 120 foot mooring arms to place ship's hawsers on pier mooring bollards, and dock the ship alongside a pier from a distance off between two already moored ships, with only one man handling each mooring arm and without the assistance of tugs. The complete system will provide constant tension control, and simplified mooring and handling of lines. Construction of the constant tension mooring winches for the telescopic arm has been substantially completed. Fabrication of the mooring arm and assembly and shop test of the completed system are soon to be undertaken.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0317, TRANSITIONAL CONTAINERSHIP CONCEPT

UNKNOWN, George G. Sharp Incorporated, *New York, New York*

Purpose: To determine the means for ready changeover of a ship's cargo hold from a 100 percent break-bulk operation to an efficient all container handling operation as cargo demand dictates.

Description: This research study will examine the problems of designing a ship's cargo handling arrangements and equipment to permit 'instant' conversion from a 100 percent break-bulk cargo ship to a pallet carrier or to a cellular containership, without sacrifice in operating efficiency, and without the need for expensive structural modifications to the ship.

The ship selected for study and comparison is comparable to the 'standard' mariner that is in use for general cargo today - length-565 ft., beam-76 ft., break-bulk capacity - 812,000 cu. ft., speed - 20- 22 knots.

A basic hold module was developed to satisfy all functional requirements, and from this three conceptual designs were prepared. The last of the three is being developed in more detail with emphasis given to special structural features for container operations. Cost estimates of the transitional ship will be included.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0318, HULL DESIGN - MODULAR DECKHOUSE

UNKNOWN, J.J. Henry Company Inc. , *New York, New York*

Purpose: To develop means for reducing ship construction costs by applying modular concepts to the design, fabrication, and outfitting of deckhouses.

Description: The most suitable distribution and amount of space needed to accomodate a 35-man crew was investigated to determine the manner in which an efficient functional layout could be arranged that would be simple and inexpensive to install. The layout was required to be expandable or retractable to accomodate crew sizes at variance with the base number. A vertically oriented sub-division of the house separated into three major subassemblies around the machinery trunk. with the pilot house as a separate module on top, was selected as the best means to minimize field connections made abroad ship.

A fabrication concept was investigated in conjunction with a shipyard and a joiner contractor by which outfit could be prepositioned at appropriate levels and in predetermined sequence for direct insertion into the open face of each structural subassembly.

Each fabrication and installation process was analyzed to determine the manhours which could be saved by permitting wider use of bench work in place of field work, reduction of trade interference, and maximum use of modular construction. Economic analysis included the cost of all special facilities materials and jigs.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0319, ROLL DISTRIBUTION OF A NUCLEAR CARGO SHIP WITH AND WITHOUT FLUME STABILIZATION

UNKNOWN, J.J. Mcmullen Associates Inc. , *New York, New York*

Purpose: To determine the effects of flume stabilization on the motions of large nuclear powered cargo vessels under severe sea conditions and zero speed.

Description: Analysis was made of the predicted rolling motions of a large nuclear powered containership, at zero speed and lying in the trough of the waves, to provide design criteria for the reactor plant and to evaluate the effectiveness of the flume stabilization system in reducing rolling under these conditions. The probable sea states on Trade Route 12 were used in predicting rolling.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0320, FULL SCALE STRESS MEASUREMENT TESTS OF GREAT LAKES ORE CARRIER

UNKNOWN, Soc. of Nav. Arch. & Mar. Eng. , *New York, New York*

Purpose: To obtain statistical data on wave induced stresses in a typical modern ore carrier operating on the Great Lakes, and to relate these stresses to measured wave and weather data, in order that design criteria appropriate to super size ore carriers of up to 1,000 feet in length can be developed.

Description: This project is a joint cooperative venture initially supported by the Maritime Administration, Lake Carriers Association, American Bureau of Shipping, and the Society of Naval Architects and Marine Engineers who are coordinating the project. Instrumentation to measure hull stresses consists of transducers located amidships on the underside of the port and starboard main deck plating of the RYERSON, and at the forward and aft quarter points.

Data is recorded periodically on tape which monitors all points simultaneously. The wave data is derived from the ship's log and from wave buoys launched from the RYERSON under storm and high wave periods.

The third season of data collection is under way. This third season is being devoted largely to evaluation of course changes as a means to minimize springing. Two instrumented ship models are being tested at Davidson Laboratory to provide a means to improve predicting capability. One model is of the 730 foot EDWARD L. RYERSON, and the other is of 1,000 foot future ore carrier. The results of these investigations will also generate useful information on techniques for developing more accurate scantling criteria for all types of supersize ships.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0321, DYNAMICS OF MOORED BUOY SYSTEMS USED IN OCEANOGRAPHY R&D AND SURVEILLANCE

J.H. NATH, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Objective: Effective use of moored buoy systems for research or operations will require a knowledge of the noise generated in various buoy-mounted instruments by motions of the anchored buoy.

In support of this requirement, this research will develop a capability for predicting statistically the motion at any point on the anchored buoy system given information on the ocean currents, ocean waves, and wind force on the surface buoy.

Approach: This is a laboratory effort involving the preparation of a computer program to simulate the motions of an anchored buoy, of medium size, along with its mooring cable. The complete set of dynamic equations, which relate this computer-simulated anchored buoy to the forces acting on it, will then be solved to give the motions resulting from any given set of forces.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0322, MARINE ATMOSPHERIC RESEARCH FACILITY

S.J. NESHYBA, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Support is provided for the construction of a moored offshore, marine meteorological platform, including a basic set of sensors, a data telemetry system, and sufficient power and safety equipment. The platform will be used to support research in 1) marine meteorological phenomena, 2) coastal air processes as related to weather modification, 3) air-sea exchange processes, and 4) meteorological turbulence near the ocean interface.

SUPPORTED BY U.S. National Science Foundation

8.0323, SHAFT HORSEPOWER SERVICE ALLOWANCE FOR SHIPS

G.H. LEVINE, Robert Taggart Incorporated, *Fairfax, Virginia* 22030

A study has been undertaken to establish a more rational method of determining the shaft horsepower service margins for ships. The end results are to be an analytical procedure for determining the service margin and a delineation of the types of data necessary to solve the problem and the methods necessary to obtain this data.

SUPPORTED BY Society of Naval Architects & Marine Engr.

8.0324, FUNCTIONAL AND ECONOMIC ANALYSIS OF SHIP MANEUVERING SYSTEMS

UNKNOWN, Robert Taggart Incorporated, *Fairfax, Virginia* 22030

Purpose: To devise modifications to merchant ship maneuvering and control systems which will upgrade operating efficiency and improve economy.

Description: This investigation includes analysis of maneuvering and control systems currently in use and the study of new concepts. A detailed analysis has been made of the effectiveness of rudder operation in the propeller race of a high-speed, single-screw merchant ship, and the analytical results confirmed by shipboard measurements and observations.

A new concept for steering configuration which shows great promise for improved performance both at low ship speeds and during ocean transit is under study. This steering unit is expected to require much less power and be less complex than existing steering machinery. Automatic steering control, which has been found to induce undesired ship motions, is being investigated more thoroughly.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8M. SANITARY ENGINEERING

(see Chapter 6e on Water Quality and Pollution.)

8.0325, OCEANOGRAPHIC FACTORS IN THE FUNCTIONAL DESIGN OF WASTE DISPOSAL SYSTEMS

J.W. JOHNSON, Univ. of California, Water Resources Center, *Los Angeles - U.C.L.A., California* 90024

In the design of waste disposal systems, such as ocean sewer outfalls, cooling water waste lines from nuclear power plants, etc., a large variety of technical problems remain to be solved to place such sound design on a sound scientific basis. The three major areas of studies have been: 1. The mixing of a buoyant jet being discharged horizontally at the water surface. 2. The mixing of a series of buoyant jets being discharged horizontally from both sides of a manifold placed at the bottom of a tank. 3. The mixing caused by the mass transport associated with surface waves having a circular normal directional spectra.

The laboratory work done previously at UCB in regard to Item 1 was re-examined, and compared with the results of work done subsequently by other institutions. These results were then compared with the two sets of prototype data with which the investigators were aware: The Pacific Gas & Electric Plant at Morro Bay, California, and the discharge of the Columbia River into the North Pacific Ocean. The data compared favorably, on a gross basis. It became evident that the laboratory work should be extended to much smaller values of Froude number and that the statistical fluctuations of temperature and salinity in the mixing jet should be studied in detail.

In regard to Item 2, the results of the studies of single jets by a number of investigators were compared, and a preliminary report written on the findings. It was evident that no additional work need be done on the portion of a single jet between the bottom and surface, but that there is essentially no information on the interaction of multiple jets from a manifold. The laboratory equipment has been designed, constructed and tested, with preliminary tests made.

The results of a theoretical study of Item 3 have been negative, in the sense that there appears to be no mixing caused by the mass transport of waves with a circular normal distribution. However, the theoretical study was linear, and there may be some nonlinear mechanism that exists.

SUPPORTED BY University of California

8.0326, MODEL ADVANCED WASTE-TREATMENT PLANT

A. MACHIS, Washington Suburban San. Comm. , *Hyattsville, Maryland*

The objective of this project is to design and construct a 5 mgd advanced waste treatment plant at the Commission's Piscataway Wastewater Treatment Plant to demonstrate the high efficiency removal of phosphorus, BOD, suspended solids and refractory organics. The AWT plant is planned to consist of lime precipitation, lime recovery, recarbonation, filtration, activitated carbon adsorption, and activated carbon regeneration.

Research by the Federal Water Pollution Control Administration and others has shown the feasibility of attaining improved removals of carbon and phosphorus from municipal waste discharges. The work has been primarily in the laboratory and small pilot plants; now it is ready for larger pilot scale or full-scale operation. The Piscataway Plant is a particularly appropriate site because of joint FWPCA-WSSC cooperation in AWT and because of the interest in water pollution problems in the Potomac Estuary.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl
Washington Suburban Sanitary Commission

8.0327, SYSTEMS ANALYSIS FOR SHIPBORNE MUNICIPAL INCINERATION

M.W. FIRST, Harvard University, School of Public Health, *Boston, Massachusetts*

This work is concerned with: (1) fundamental studies of the atmosphere 10-30 miles off-shore and its capacity to absorb gaseous wastes without polluting the coastal areas; (2) analysis of the effects of large scale dumping of incinerator residues on the marine life in the vicinity and on the bottom; (3) an investigation of the deposition and distribution of solid residues on the ocean floor; (4) applications of the methods of systems analysis and high speed computers to optimize collection networks oriented towards waterfront ship loading points, location of dockside transfer stations, and scheduling of ship movements with respect to the distribution of loading and burning times, load size, crew shifts, etc. (5) use of operations research methods to investigate the relative merits of all applicable solid waste management systems on the basis of urban configuration, geographical location, pollution control practices, etc.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

8.0328, CONSTRUCTION OF A FACILITY TO DEMONSTRATE OFFtSHORE UNDERWATER TEMPORARY STORAGE OF STORM OVERFLOW FROM A COMBINATION SEWER

W.J. BANDY, Karl R. Rohrer & Associates, *Akron, Ohio* 44311

Combined sewer storm overflows are a source of water pollution. The proposed work is to completely engineer a demonstration facility for temporary underwater storage of these overflows. The storage will be in large flexible (rubber) containers anchored underwater in a water body. The system will automatically fill during a storm event, and a pumped flush system will be used to empty the tanks into the interceptor sewer after storage.

The system capacity will be designed for a particular site after climatological, hydrological, and topographic studies are performed.

Instrumentation will include a recording rain gage, continuous flow recorders, and an automatic sampling device.

The site selected is an 18 acre drainage area located in Sandusky, Ohio. The existing leaping weir overflow structure is at the foot of McEwen Street. The tanks will be installed in Sandusky Bay of Lake Erie. The flexible tanks will be of rubber coated nylon construction, and 100,000 gallon capacity.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

8.0329, SALT WATER ENTRAINMENT FOR DILUTION IN SEWER OUTFALLS

R.E. NECE, Univ. of Washington, School of Engineering, *Seattle, Washington* 98122

This investigation is an experimental and analytical study of the mechanism of the entrainment of a fluid into a conduit passing through an infinite volume of this ambient fluid and through which flows a different fluid. The particular motivation is to obtain basic information which could be applied in the sanitary engineering design of sewer outfalls discharging into salt water. In this case, where density differentials exist, entrainment of salt water into the outfall prior to ultimate discharge would decrease the density differential between effluent and receiving water, thereby decreasing the amount of diffusion necessary to produce acceptable sewage concentrations at the water surface. Such entrainment could be accomplished by providing appropriate inlets through the wall at a reduced-pressure 'venturi' section in the outfall pipe.

This study is to treat a few relatively simple geometries in some detail. Attention is to be focused on those factors influencing entrainment rates, namely: density and pressure differentials between ambient and initial conduit fluids, velocity of approach in the conduit, and inlet geometry. Mixing patterns within the conduit are to be studied. It is planned to extend the tests to the case of an ambient fluid which is in motion.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

8N. UNDERWATER CONSTRUCTION

(Soil and Rock Mechanics; Habitat Installation; Welding. See Chapter 8d on Coastal Engineering)

8.0330, LABORATORY STUDIES TO DETERMINE ROCK PROPERTIES UNDER HYDROSTATIC (SEA WATER) PRESSURE

S. CHI, U.S. Dept. of Interior, Marine Min. Technol. Ctr. , *Belvedere - Tiburon, California* 94920

A literature search will be made on residual stresses occurring in rocks of the types to be tested. If equipment can be made available by Stanford, ore samples will be tested in a triaxial cell at various pressures corresponding to various depths of submergence. Physical properties of the rocks will then be measured in order to begin to understand the effects of sea water on seafloor rocks (such an understanding will lead to improved methods for seafloor rock penetration and fragmentation).

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0331, SEA BED INSTALLATION

A.D. NEWSHAM, North Amer. Rockwell Corp. , *Long Beach, California* 90803

This research program was undertaken to further develop the capabilities to support sea bottom installations and operations through the effective selection and preparation of ocean floor construction sites. Two primary areas were considered: (1) the foundation emplacement associated with the installation of an above-bottom habitat, and (2) the modification of the surrounding bottom terrain to enhance the capability for performing mission taks. Foundations for manned habitats, such as stands, mats, piles and anchors, were assessed in terms of habitat configuration and bottom conditions. Site modification for the purposes of accomodating the foundations and structures encompassed such tasks as overburden removal, leveling, rock drilling/blasting, and soil stabilization. Thirty-three variations in bottom conditions were considered in the investigations. The experience and state-of-the-art of the offshore development industry (oil drilling and mining) was a factor in assessing currently available procedures and equipment. Two internal technical reports have been prepared documenting results of the study: 'Site Selection and Site Preparation Analysis for Manned Underwater Structures', T8-1219/020 May 1968; and 'Operational Considerations of Site Selection and Site Preparation for Manned Bottom Installation', T8-2247/020.

SUPPORTED BY North American Rockwell Corporation

8.0332, BOTTOM SOIL PROPERTIES AND FOUNDATIONS

UNKNOWN, U.S. Navy, Civil Engineering Lab. , *Port Hueneme - Point Mugu, California*

Objective: Develop the methods and equipment to determine the engineering properties of bottom soils with sufficient accuracy to permit the design of structural foundations. Properties of interest are bearing capacity, shear strength, bulk density, consolidation rates, bottom stability and classification. Installations on the ocean floor will require foundations which will provide support without settlement or scour. Proper design of these foundations requires soil samples for laboratory tests in addition to in-situ tests. Most sea floor work done in the past has been that the ococeanographers and marine geologists interested in generic classifications and chemical and physical composition of bottom materials. Consequently knowledge of engineering properties is comparatively limited.

Approach: Development of both laboratory and in-situ equipment and techniques for measuring pertinent properties of the sea floor materials. A coring tool that will be capable of obtaining a minimum disturbed core to a depth of about 30 feet below the sea floor in firm material will be developed. An in-situ plate bearing vane shear, and penetrometer device will be developed and tested. Studies will be conducted to determine the effect of the deep ocean environment on the engineering properties of sea floor sediments. Studies will also be made in areas such as sample handling and storage, laboratory testing techniques for very cohesive ocean sediments, and correlation between in-situ and laboratory results. Problems of submarine landsliding, slumping and turbidity currents must be investigated; however very limited data are available on mechanism and causes. As a consequence, the initial phase of these studies will be to review these actions from a theoretical soil mechanics aspect after which full scale field experimentation will be conducted. Study of scour and fill will be approached from direct experiments with objects placed in potentially unfavorable areas with periodic examination to observe the effects over an extended period of time.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0333, DESIGN AND CONSTRUCTION

UNKNOWN, U.S. Navy, Civil Engineering Lab. , *Port Hueneme - Point Mugu, California*

Objective: To acquire engineering data on the behavior of materials used in ocean construction and to develop engineering criteria for the design of ocean structures. The effects of the ocean environment on ocean structures is one of the primary factors which must be considered before the design of an on- or in-bottom installation can be completed. Information is available on the behavior of materials at 2500 feet and 6000 feet. However, knowledge of the effects of protective coating, biological deterioration and shallow water corrosion is limited. Various structural shapes can be adapted to the ocean environment, however, at present detailed engineering criteria are only available for the design of cylinders and spheres. Other structural shapes must be investigated and data on the behavior of standard construction materials such as concrete must be obtained. Work undertaken in this task area will provide the technological foundation to accomplish future requirements in the design and construction of ocean installations.

Approach: Achievement of this objective involves work in the following areas: Area 1: Development of fundamental information on the effects of deep ocean environment on materials. This knowledge is essential in the determination of specialized design or materials to be used in fixed installations. Area 2: Development of engineering data on the structural behavior of materials and designs in the ocean environment. Area 3: Development of specialized safety techniques and warning devices to warn of impending structural and atmospheric failures in undersea construction.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0334, ANCHORS AND MOORINGS

UNKNOWN, U.S. Navy, Civil Engineering Lab., *Port Hueneme - Point Mugu, California*

Objective: Develop the anchors and mooring systems required for surface, subbottom, and bottom installations in the oceans. The goals to be achieved under this task area are as follows: Maximum depth: 6,000 ft: holding power: 300,000 lb vertical and horizontal loads, performance: 5 years unattended. The requirement for structures and installations in ocean areas imposes new and strigent demands on anchors and mooring technology. The present state-of-the-art for deep ocean anchorage consists of dead-weight anchors and standard drag-type anchors. These anchors are massive, have low holding-power-to-weight ratio, require considerable horizontal distance to set and are difficult to handle and transport. Achievement of this task area objective will provide the capability to meet most anticipated future requirements in deep ocean anchorages.

Approach: Achievement of this objective involves the following three phases: Phase I: Development and testing of anchor designs and procedures for their rapid and efficient placement in the deep ocean. Embedment anchors offer a potentially fruitful avenue for investigation. However, drilled-in and driven type piles of various designs and configurations may well be adapted to deep ocean anchorage functions and will warrant investigations. Phase II: Development of anchor designs with the capability to resist not only uplift forces but also bearing loads. This work would fulfill the requirements of the bottom- rest type constructions required in the near future. Phase III: Development and testing of deep ocean mooring systems to meet most anticipated future needs. When Phase I and II are well underway, sufficient information will be available to proceed with mooring complexes. These complexes may involve multiple, taut line systems where packages will be anchored at depths down to 6,000 ft and they may involve combinations of systems for anchoring of large installations on the ocean floor.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0335, RELATIONSHIPS BETWEEN RATES OF SEDIMENT ACCUMULATION & CHANGES WITH DEPTH OF CERTAIN MASS PHYSICAL PROPERTIES IN MARINE SEDIMENTS

A.L. INDERBITZEN, Lockheed Aircraft Corporation, *San Diego, California* 92101

The purpose of the study is to determine the mathematical relation- ships between rates of sediment accumulation and changes in shear strength and water content with depth in marine sediments. Cores obtained from four geological provinces of Southern California are being utilized. The environments are: basin floors, basin slopes, insular shelfs and San Diego Bay. Each core is analyzed for grain size, water content and shear strength at various depths in the core. Data is then processed through various statistical and curve fit programs to determine the relationships of these parameters to the different rates of accumulation for these environments.

SUPPORTED BY Lockheed Aircraft Corporation

8.0336, HIGH PRESSURE ROCK STUDIES

R.B. GORDON, Yale University, School of Engineering, *New Haven, Connecticut* 06520 (NONR)

This task is a continuing program on laboratory experiments to investigate the non-elastic properties of minerals and rocks at temperatures and pressures that occur in the earth's crust and upper mantle. Studies of internal friction in crystalline rocks with and without a fluid phase will continue. These experiments are being carried out at low frequencies, characteristic of seismic waves. Plastic deformation of single mineral crystals will be studied using etching techniques.

While this research is concerned primarily with these properties as they relate to the physical state of the earth's interior, the results obtained and experimental techniques developed will contribute to our knowledge of the behaviour under stress of rocks beneath the ocean floor.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0337, GEOLOGICAL OCEANOGRAPHY - PHYSICAL PROPERTIES

J.J. GALLAGHER, U.S. Navy, Underwater Sound Lab. , *New London, Connecticut*

To determine those environmental factors affecting the undersea uses of the ocean; to investigate and define the physical properties of ocean sediments; determine the critical properties of sediments which affect the stability of structures and equipment placed on the sea floor.

Approach: Develop a shear strength and plate loading device for use of DRV's. Investigate the effects of chemical bonding on shear strength. Study bio-chemical properties of marine sediments and generally improve measurement and analysis techniques of the mass physical properties of sediments through a contract with the University of Rhode Island. Develop controlled photographic techniques for bottom roughness.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0338, SUPPORTING SYSTEMS

P.H. CAVE, U.S. Navy, Facilities Engin. Command, *Washington, District of Columbia* 20390

Objective: Provide, maintain and operate the supporting systems required for in-situ and laboratory tests of ocean soils, materials, components and models. All construction work in the ocean requires preliminary work or studies in a laboratory or in-situ to prevent costly failures of equipment in the ocean. For this purpose, simulated hydrospace facilities and in-situ testing equipment must be built, maintained and operated. By the end of FY 68 there will exist at NCEL a deep ocean simulation laboratory consisting of six 9-in vessels; and one 6-ft vessel. Also there will exist a 6000-ft deep ocean test, instrument, placement and observation system (OTIPOS) for making in- situ tests. During the past year the deep ocean simulation laboratory has been used extensively in support of in-house laboratory projects such as studying the spheres, and short and long term critical pressure test on acrylic windows. In addition, pressure testing of material and equipment for other naval activities such as the pressure testing of: buoyancy spheres for CURV; lights and cameras for Sealab; and proof testing of polaris junction box have been conducted. Achievement of the objective of this task will allow the navy to continue to meet requirements for: pressure and in-situ testing in support of research and development; and proof test required before equipment can be used in the ocean.

Approach: Achievement of this objective involves work at the Naval Civil Engineering Lab and in industry in the following areas: Area I: maintain and operate the deep ocean simulation laboratory and the deep ocean test instrument placement and observation system. Area II: improve existing systems and formulate the new systems so that the adequate facilities exists when the need for conducting studies in them arises.

SUPPORTED BY U.S. Dept. of Defense - Navy

8. ENGINEERING AND TECHNOLOGY

8.0339, DEEP OCEAN SYSTEMS

D.C. PAULI, U.S. Navy, Office of Naval Research, *Washington, District of Columbia*

Objective: To develop new techniques and equipments to enhance the performance of useful undersea work and the technology of undersea installations.

Three programs are being pursued, primarily through industry. Advanced diver equipment is being studied and developed to enable a free-swimmer to go much deeper and do much more work than is now possible. For utilization on DRV's, undersea robot mechanisms, etc., a new manipulator concept employing tensor elements is being pursued. This manipulator will be light, less bulky, and far more flexible than any equivalent equipment now in use. The problem of efficient measurement of ocean-floor programs are all aimed at improving navy capability of undersea construction, salvage, rescue, and recovery. Time-wise results from all three programs would be beneficial today and for many years to come. In respect to general objective (3) above, two programs are underway. Solutions are being sought for heating and breathing problems in the manned undersea installations which are currently required for the Navy man-in-the-sea effort.

Approach: All the above programs are proceeding in general through following phases (1) establish requirements; (2) study possible solutions; (3) select trial solutions; (4) design and analyze; (5) model and/or component parts fabricate and test; (6) prototype test and evaluation. The order can change and there are often overlaps or concurrent efforts in these phases, but each of the programs fits this general outline.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0340, CIVIL ENGINEERING STRUCTURES IN THE OCEANS

P.G. MAYER, Georgia Inst. of Technology, School of Engineering, *Atlanta, Georgia* 30332

Engineering structures in the ocean involve forces and constraints which demand attention to the interrelationships between the soil dynamics of the ocean floor, the hydrodynamics of wave action and of the viscous damping, and the structural response characteristics. These interrelationships must be understood as random phenomena and must be treated by probablistic methods.

The present study involves the formulation of a structural model based on continuous mass distribution, an analysis of the wave force spectrum using the theory of random processes as applied to structure and the ocean, and an analysis of foundation conditions. The synthesis of the above will be attempted by numerical methods.

Ph.D. thesis on this project by Billy L. Edge completed in June 1968.

SUPPORTED BY Georgia Institute of Technology

8.0341, DEEP SEA SEDIMENT STUDIES

A.F. RICHARDS, Univ. of Illinois, Graduate School, *Urbana, Illinois*

Research on the mass physical and engineering properties of deep- sea sediments and development of instruments and techniques for measuring these properties will be continued. The vane shear and gamma-ray densitometer in situ probes will be modified for use in deep water and will be field tested. A laboratory study to determine means for obtaining valid shear strength data from sediment cores, will be undertaken. The development of a computer capability for reduction, analysis, and storage of soil-mechanical data will be initiated.

Information concerning the interaction of both acoustic waves and man-made structures with marine sediments is important in naval operations. Such information requires an understanding of the physical and acoustical properties of marine sediments, their interrelationships, and the techniques necessary for properly measuring them. This program will help provide the required understanding.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0342, ELECTROKINETIC SOIL STUDY

M.I. ESRIG, Cornell University, School of Engineering, *Ithaca, New York* (NONR)

This investigation, dealing with electrically induced relaxation of the breakout forces required to free metallic objects buried in soils, will be completed. The results of laboratory experiments will be analyzed and the theoretical basis for the observations will be considered.

Electrical techniques for the reduction of breakout forces and conversely for localized soil stabilization may have widespread applications in salvage operations and in ocean-bottom construction.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0343, OCEANOGRAPHIC RESEARCH

R.F. HILL, Univ. of Rhode Island, School of Engineering, *Kingston, Rhode Island* 02881

Objective: Identify those environmental parameters near the ocean/bottom interface that have engineering significance; develop a detailed technical description of these parameters as a function of global position, and document the detailed descriptions so as to be of maximum benefit to deep ocean system planners and designers. The pertinent parameters include current magnitude, turbidity, dissolved corrosive agents, bottom bearing strength, bottom roughness, soil adhesion, etc.

Approach: Develop a list of and describe the technical scope for those environmental parameters which are pertinent to the engineering of deep ocean systems. Conduct a survey of technical information resources, such as the published literature, unpublished reports, interrogation of experts, etc. Analyze and evaluate this information to determine the present state-of-knowledge of the pertinent oceanographic environment. Develop a detailed description of those environmental parameters that should be observed in situ to close the gap between the present state-of-knowledge and the desired understanding of the pertinent oceanographic parameters resulting in a detailed catalogue of the pertinent parameters, the necessary spacial and temporal sampling required to measure these parameters, the necessary accuracy of those parameters, and the preferable format of the data. A detailed technical report will result from this contract.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0344, UNDERWATER WELDING

F.J. PILIA, Ocean Systems Incorporated, *Reston, Virginia*

Dry Welding - Experiments have been conducted and operational tests have proven techniques for Argon shielded TIG welding to depths down to 165 feet. Work is underway to perfect a Helium shielded TIG technique and to verify the technique at depths down to 600 feet. Helium must be employed as shield gas due to the narcotic effect of Argon under pressure.

Wet Welding - OSI is attempting to develop a wet welding machine employing the MIG process which will provide faster and cleaner welds than wet stick welding.

Dry MIG tests have been conducted at depths down to 100 feet. Dry tests will be continued down to 200 feet and then wet tests will be attempted.

SUPPORTED BY Ocean Systems Incorporated

9. COASTAL ZONE MANAGEMENT AND USE

(recreation, Conservation, Planning, and Management)

9.0001, ECONOMIC EVALUATION OF PRIMARY BENEFITS FOR FISHING AND HUNTING BASED ON THE NATIONAL SURVEYS OF FISHING AND HUNTING

S.V. CIRIACYWANTRUP, Univ. of California, Water Resources Center, *Berkeley, California* 94720

The primary objective is to appraise and analyze the data collected in the 1960 National Survey of Fishing and Hunting with a view to improving the projections of 'demand' for saltwater and freshwater fishing, small game, big game, and waterfowl hunting.

Relevant and reliable projections of the future consumption of fishing and hunting are valuable guides to future investment programs in land, water, and facilities development. Good projections constitute valuable checks as to the adequacy of water development programs, both at the activities and the regional level.

The nature and extent of the relationships between participation in the respective sports and other variables which might influence participation; for example, trip costs, distance of trip, expenditure on equipment, and the characteristics of the sportsman's family income, age, and profession are being ascertained by multiple regression analysis.

SUPPORTED BY University of California

9.0002, EARTHQUAKE HAZARD - A PUBLIC POLICY PROBLEM IN THE SAN FRANCISCO BAY AREA

K. STEINBRUGGE, Univ. of California, Inst. of Governmental Studies, *Berkeley, California* 94720

This will be a study covering the inevitability of future earthquakes, earthquake history in the Bay area and the significance of the public of the Bay area faults. The civil and structural engineering problems and the geological problems will be discussed; also such special problems as seismic sea waves and earthquake prediction. The governmental role and public policy will include relationships between federal, state, regional and local agencies involved, and will stress the great need for a planning agency to coordinate public action.

SUPPORTED BY University of California

9.0003, A SURVEY OF THE MARINE ENVIRONMENT FROM FORT ROSS, SONOMA COUNTY, TO POINT LOBOS, MONTEREY COUNTY

M.W. ODEMAR, State Dept. of Fish & Game, *Sacramento, California*

The primary purposes of the study were (1) determine whether there were any acceptable ocean areas which may receive wastes from the proposed California Central Valley Drain; and (2) determine areas (if any) where the least damage to the biota would result from the waste discharge.

Other purposes of the study were (1) to evaluate beneficial uses of the marine environment between Bodega Bay and Point Lobos; (2) collate biological data pertaining to organisms in the study area; (3) survey the benthic biota at each candidate discharge site; and (4) collect limited oceanographic data at each candidate discharge site. Data from the various sub-studies were used to develop the recommendations presented in the final report July, 1968.

SUPPORTED BY California State Government

9.0004, USE OF THE COASTAL ZONE FOR THE U. S. COASTLINE OF LAKE ERIE AND LAKE SUPERIOR

A.B. BIGLER, Natl. Planning Association, *Washington, District of Columbia*

The contractor will conduct investigations and analyses on the use of the coastal zone for the U. S. coastline of Lake Superior and Lake Erie intended to aid in future policy planning for these areas. Specific tasks include: (1) Review of background studies of factual data about the two lakes and their utilization and the economic and social ends served; (2) Analysis of the effectiveness of measures employed in the past for determining utilization of coastal zone resources, including case studies of selected conflicts; (3) Assessment of the potentials for applying marine science and technology to achieving greater multiple use, or more optimal use, of coastal zone resources; (4) Identification and evaluation of new or different measures to protect higher-level utilization of coastal zone resources; (5) Analysis of international problems and opportunities in achieving optimal use of lake waters and lake-bed resources, and recommendations of desirable new measures.

SUPPORTED BY Natl. Council on Marine Res. & Engin. Dev.

9. COASTAL ZONE MANAGEMENT AND USE

9.0005, ISLAND STUDY

S. YOUNG, U.S. Dept. of Interior, Bureau of Outdoor Recreation, *Washington, District of Columbia* 20240

This survey and planning study has three major objectives: (1) Inventory all 10-acre or larger islands in the U.S., Puerto Rico, and the Virgin Islands by size, ownership, and development status. (2) Identify and evaluate those islands which have significant wilderness, historical, or other recreational values. (3) Develop a program for island conservation.

The Island Study was started during fiscal year 1967. The inventory phase and the detailed studies of those islands with significant recreational values have been completed. The final report, outlining a program for island conservation, should be released during fiscal year 1969.

SUPPORTED BY U.S. Dept. of Interior - Bu. Outdoor Rec.

9.0006, INVENTORY AND ATLAS OF GULF COAST SPORT FISHING FACILITIES

N.G. VICK, U.S. Dept. of Interior, Bureau of Sport Fish. & Wlfe., *Panama City, Florida* 32401

A complete inventory of fishing facilities and fishing areas for the coast of the Gulf of Mexico from Brownsville, Texas to Key West, Florida will be made. All available reports and brochures on salt water sport fishing will be obtained through the circulation of a facilities checklist to recreational and fishing committees of chambers of commerce in coastal communities. Field trips will be made to confirm and add to the data obtained through correspondence. The results will be reviewed by State Conservation agencies for accuracy and completeness. The information will be published as a single atlas consisting of unit maps which together will cover the whole coast.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

9.0007, HYDROLOGY OF COASTAL AREA IN THE VICINITY OF RICEBORO, GEORGIA

A.N. CAMERON, U.S. Dept. of Interior, Water Resources Division, *Atlanta, Georgia*

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of Georgia.

Purpose - To determine the hydraulic and chemical characteristics of surface waters in the North Newport River Drainage Basin and the piezometric surface and quality of water in the principal artesian aquifer in the vicinity of Riceboro prior to the beginning of operations of a large industry as well as after the plant is in operation.

Methods - The tidal behavior of the Newport River estuary will be studied and the amount of interchange between salt and fresh water, the time of travel through the estuary, and the dispersion patterns will be determined. Discharge measurements will be made. Chemical analyses will be made on water samples collected periodically and water quality monitors will be installed. Wind direction and velocity component data will be recorded at one station. Continuous water level recorders will be installed on four wells. Electric and gamma-radiation logs will be made of selected wells within 30 miles of Riceboro to determine the amount of casing and depth of the well and aid in interpretation of the geology and identification of the aquifer. Aquifer tests will be made at the plant site after completion of the plant wells.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey
Georgia State Government

9.0008, SEA SLED AND SCUBA RECONNAISSANCE OF INSHORE AND STUDIES ON EFFECT OF ARTIFICIAL SHELTERS ON STANDING CROP OF FISHES

H.M. SAKUDA, State Dept. of Land. Nat. Res., *Honolulu, Hawaii* 96813

Objectives: 1. To compile a qualitative and quantitative inventory of physical and biological factors of the coastal waters of the State. 2. To evaluate the effectiveness of artificial shoals as a fishery management tool. 3. To compile fishery management data from marine sanctuaries. 4. To construct artificial shoals in areas selected for habitat improvement.

Procedure: 1. With the use of SCUBA gear, the standard underwater transecting procedure developed during previous segments will be utilized to gather information on bottom topography and estimates of standing crop of fish. Resulting information will be applied in the selection of sites for future construction of artificial shoals. 2. The shoals constructed during the past segments will be examined from time to time and transects will be made to evaluate the effectiveness of the shoals in increasing fish life. 3. In an attempt to gather information on the effects of fishing pressure on standing crops of fishes, selected areas will be set aside as sanctuaries. Transecting will be conducted prior to and during the use of such areas as sanctuaries for purposes of comparing standing crops of fishes. 4. Construction of artificial shoals will be continued, utilizing damaged concrete pipes or other suitable materials.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Hawaii State Government

9.0009, HAWAII STATE COMPREHENSIVE OUTDOOR RECREATION PLAN

S.M. MARK, State Dept. of Plan. & Econ., *Honolulu, Hawaii*

This project will investigate all phases of existing and proposed outdoor recreation, both urban and non-urban, of the State, its political subdivisions, the federal government, and private interests, including but not limited to, forests, reservoirs, lakes, rivers, sea shorelines, multiple-use areas, farms, hunting preserves, refuges, parks, natural areas, historic and cultural sites, and other significant outdoor recreation areas. It will consider such activities as hunting, fishing, skiing, hiking, camping, picnicking, pleasure driving, boating, swimming, golfing, and other forms of outdoor recreation in which people of the State, including handicapped and underprivileged, may participate in. It will serve as a guide for enhancing and preserving the natural beauty of the islands and its recreational areas. It also will consider and take into account the coordination of the activities of all agencies of the State, federal, and county governments relating to outdoor recreation.

The Plan will attempt to project estimated general recreation information for the State to 1985, based both on an analysis of present use of areas and facilities and on trends in population, income, leisure time, mobility, recreation habits, and interests. More detailed and specific demand and programmed facilities data will be provided for the next five-year period. Assuming the Plan effectuation to begin in early 1968, this will cover the period to 1972.

In accomplishing the above efforts will be made towards investigating the feasibility and possible methodology for utilizing Automatic Data Processing system following or adapted to that utilized in the national survey in maintaining recreation inventory and investigating and analyzing methodologies, concepts and alternatives for accommodating and integrating national concerns in programs for highway beautification, preservation and enhancement of natural beauty, and the handicapped and underprivileged in Hawaii's outdoor recreation areas and facilities.

SUPPORTED BY U.S. Dept. of Interior - Bu. Outdoor Rec.

9.0010, BAYOU LAFOURCHE SEDIMENTATION STUDY, LOUISIANA

W.H. BOYLE, U.S. Dept. of Interior, Water Resources Division, *Baton Rouge, Louisiana*

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of Louisiana.

Purpose: To determine the rate of sedimentation and the resulting channel characteristics such as size, shape, and slope.

Methods: A quantitative analysis of data collected by the U. S. Geological Survey and other agencies since 1955 will be initiated so that an estimate of the amount of sediment coming into the bayou can be made. This estimate will be compared to an amount derived by using a gamma probe at 18 cross-sections within the study reach by which the density of the sediment at each cross-section is obtained. Finally a prediction of the stabilized channel will be made for the bayou within the study reach.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey
Louisiana State Government

9.0011, 1965 SALT-WATER ANGLING SURVEY

J. CLARK, U.S. Dept. of Interior, Sandy Hook Marine Lab., *Highlands, New Jersey*

Description of Work: Supply information and plan layout for interview forms to be used by Bureau of Census for nationwide survey of information on species, numbers, weights, areas and methods of fishing for salt water game fishes. Provide a list of primary and secondary game species for each sampling area. Assist the Bureau of Census in solving taxonomic problems in field canvass data. From compilations furnished by the Bureau of Census, prepare a complete data report for publication. Discuss results with appropriate fish and game officials where necessary.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

9.0012, INVENTORY AND ATLAS OF MARINE SPORT-FISHING FACILITIES

B. FREEMAN, U.S. Dept. of Interior, Sandy Hook Marine Lab., *Highlands, New Jersey*

A series of line maps will be prepared as an atlas and will summarize marine sportfishing facilities and fishing grounds of the Atlantic coast from Maine to Florida. Intended as both a comprehensive guide for sportsmen and an inventory of facilities, each map will show locations of boating facilities, supplies, and services, as well as principal roads and towns. Water depths, fishing grounds, and common game fish will be indicated to a distance of ca. 30 miles offshore. The atlas will include location of natural and artificial reefs as well as principal wrecks. Tabular summaries accompanying each map will list fishing piers and public shore fishing areas, State and Federal parks, wildlife areas and associated recreational facilities.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

9.0013, DESIGN, CONSTRUCTION AND LONGEVITY OF ARTIFICIAL FISHING REEFS

R.B. STONE, U.S. Dept. of Interior, Sandy Hook Marine Lab., *Highlands, New Jersey*

Design and install artificial fishing reefs of junk cars, concrete materials and scrap tires on approved reef sites off Monmouth Beach, N. J., Atlantic Beach, N.Y., Charleston, S.C., Jacksonville, Fla., Palm Beach, Fla. and in Biscayne Bay, Miami, Fla. Arrange these to provide comparative data on the design and type of materials used in relation to the effectiveness and longevity of fishing reefs. Make periodic underwater observations on condition of materials, encrusting organisms and population of fish attracted to reefs. Conduct laboratory tests on reef models of the action of currents, tides and other environmental factors.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

9.0014, SURFACE AND GROUND WATER POTENTIALITIES OF THE MULLICA RIVER BASIN

M.L. GRANSTROM, Rutgers The State University, School of Engineering, *New Brunswick, New Jersey* 08903

The proposed research project involves a systems analysis study and an ecological field investigation of aqueduct water transfer from the Mullica River Basin (containing a large state water reserve) to several New Jersey cities. This study will determine the: 1) cities which will have future demands for Mullica River water 2) optimum conjunctive surface and ground water development 3) economic effects of water withdrawal on shellfish, other biota, recreation, and waste assimilation capacity of the river and estuary.

The systems analysis approach will involve applications of extremal mathematics, such as linear programming, or simulation and stochastic processes. Fish spawning and nursery grounds studies and plankton dredging surveys will determine the distribution of these biota with respect to the existing and projected hydrography of the river-estuary system. Dissolved oxygen, salinity, and other water quality parameters will also be measured for the mathematical model. Project results will be applicable to other river basins which have conjunctive surface and ground water potentialities which affect the estuarine ecology.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
Rutgers The State University

9.0015, CRITERIA FOR EVALUATING THE QUALITY OF WATER BASED RECREATION FACILITIES

C.C. STOTT, Univ. of North Carolina, School of Education, *Raleigh, North Carolina* 27600

Statement of Problem - On the basis of opinions of users of water based recreation facilities and the opinions of professional recreation experts, rating standards will be established for quality of swimming, boating, and fishing. These standards will be used in evaluating the adequacy of facilities for at least one geographical area.

Objectives - To establish criteria of a practical nature that would aid in determining the quality of water based recreation facilities; to develop standards for evaluation purposes; to develop standards that would serve as guidelines for the operators of water based facilities.

Procedures - To determine existing practices relative to current standards; to determine from the user of water based recreation facilities data essential to the adoption of criteria; to determine acceptable practices as performed by practitioners of good professional reputation. Major Subjects - Marinas: boat docks, boat ramps, boat hoist, marine repair and services, boat mooring, boat anchoring, boat wet storage (boat slips), boat dry storage, floats, docks, piers, tackle shop and supplies, refreshment services, fishing bait, toilet, buoy safety markers. Swimming Areas: bathhouses, beaches, lifeguard staffing patterns, swimmer lifeguard ratio, swimmer loads. Fishing Facilities: fishing piers, boat rentals, rescue squads. The data will be collected over an area of several states in the East during June, July, and August, 1965. Such data will be processed at North Carolina State University at Raleigh.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
North Carolina State University

9.0016, PUBLIC INVESTMENT CRITERIA FOR WATER-ORIENTED RECREATION IN THE LAKE ERIE BASIN

R.A. TYBOUT, Ohio State University, Graduate School, *Columbus, Ohio* 43210

The project has three parts: 1) The measurement of demand for water-oriented recreation at numerous sites. 2) Analysis of costs of pollution abatement and recreation facilities at the same sites. 3) Evaluation of the relative merits of alternative public investments for recreation enhancement and of selected financial policies.

Each part is assigned a year of research time. Demand will be measured by a simultaneous-origin adaptation of the Hotelling-Clawson method. Shifts in demand due to pollution and income changes will be measured and, in fact, play an important part in the determination of benefits from abatement. The analysis of costs of pollution will seek to relate marginal pollution contributions at recreation sites to costs of abatement. The third, or final part of the analysis will explore the implications of combining the results of the first two parts in a cost-benefit framework with various methods of financing, including pollution taxes, user charges and other revenue sources.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
Ohio State University

9.0017, TECHNIQUES OF PLANNING

B.A. TICHENOR, U.S. Dept. of Interior, Pacific Nw. Water Laboratory, *Corvallis, Oregon* 97330

This project has two objectives: 1. To provide consultation and assistance to projects in the Research Branch of the Pacific Northwest Water Laboratory with respect to the design of experiments, setting up a mathematical models, statistical analysis of data, use of electronic computers for data processing, and application of engineering principles and techniques; 2. To apply the techniques of operations research and systems analysis to problems in water resources management and development, giving special emphasis to those problems occurring in the Pacific Northwest.

The Laboratory will be conducting research on a broad range of water oriented problems, utilizing personnel with experience in a myriad of scientific disciplines, including chemistry, biology, forestry, oceanography, etc. The application of sound mathematical, statistical and engineering principles by this project will complement the various research groups and will result in effective utilization of the full range of techniques which can be applied to the solution of problems in water resources.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

9.0018, ECONOMICS OF WATER QUALITY FOR A REGIONAL SYSTEM

W. ISARD, Regional Science Res. Inst. , *Philadelphia, Pennsylvania* 19104

To develop workable methods for the integration of empirical materials on possible supply, demand and quality conditions for the development of an efficient water basin investment and management program. These methods would be generally applicable to water basin investment and management in various regions of the world. More specifically, our objective would be to interrelate (1) quality conditions simulated by the diffusion model for the Delaware estuary, (2) supply conditions as derived from the current simulation model for the Delaware River basin and (3) probable demand conditions projected with the use of Philadelphia Regional economic base studies, to guide investment and quality management policy on the Delaware estuary.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

9.0019, SOCIO-ECONOMIC STUDY OF NARRAGANSETT BAY, RHODE ISLAND

N. RORHOLM, Univ. of Rhode Island, Agricultural Experiment Sta. , *Kingston, Rhode Island* 02881

To identify, measure and evaluate the economic and social values of the marine resources of the Bay to the State of Rhode Island. The project will be based on secondary source information currently available to the University of Rhode Island with additional surveys or interviews being made as necessary to supplement existing data. To identify, measure and analyze economic and social trends in Rhode Island which would be significant in terms of water pollution control or land use regulation of the Bay and that portion of the watershed which is significant in determining the quality of the estuarine water resources.

To explore how benefit cost analysis techniques may be best applied to determine the effects of various combinations of beneficial uses on the estuarine resources. To identify and recommend needs for future studies or basic data systems which would be useful in obtaining optimum public benefits from use of the Bay resources.

SUPPORTED BY Rhode Island State Government

9.0020, EVALUATION OF ATLANTIC COAST ESTUARIES

G.P. SPINNER, Univ. of South Carolina, Graduate School, *Columbia, South Carolina* 29208

The project is administered by the University of South Carolina but the technical aspects are under the direction of the Marine Resources Committee, a sub Committee of the Atlantic Waterfowl Council.

The purpose of the study is to determine which of the estuarine zone ecosystems are of high priority in the life cycle of waterfowl and other marine resources. This determination will be based on the mapping of marine resources based on data supplied by cooperating agencies and will also include ownership of salt marshes and associated shoal water by conservation agencies. The needs for the resources will be determined and a plan to preserve the essential habitat will be formulated based on present plans and programs of conservation and other land use agencies.

SUPPORTED BY Belle W. Baruch Foundation

9. COASTAL ZONE MANAGEMENT AND USE

9.0021, EVALUATION OF ENGINEERING PROJECTS AND ESTUARINE DATA (ESTUARINE PROGRAM)

R.J. HOOGLAND, U.S. Dept. of Interior, Biological Laboratory, *Fort Crockett - Galveston, Texas*

Estuarine-dependent species of the Gulf of Mexico coast comprise several of the nation's most valuable fishery resources. If the nursery grounds in the estuaries are to be preserved, it is essential that the estuarine habitat of these species be protected during and following construction of water-development projects in upland basins, estuarine systems, and coastal marshes. The increasing number, as well as complexity, of construction projects require a detailed understanding of estuaries.

It is the purpose of this project to (1) assist the Branch of River Basin Studies (BSFW) by reviewing all proposed construction and water-development projects affecting western Gulf estuaries and, when warranted, recommend remedial measures to reduce adverse project effects; (2) where practical, recommend changes in water-development projects whereby the habitat would be enhanced for the fishery resources (3) inventory, organize, and keep current all published and unpublished data related to western Gulf estuaries, and (4) recommend basic research needed for protecting estuarine fishery resources.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

10. LEGAL STUDIES

10.0001, PRELIMINARY STUDIES OF INTERNATIONAL REGIMES FOR MARINE RESOURCES

F.T. CHRISTY, Resources For The Future Inc., *Washington, District of Columbia*

The basic objective is to make some preliminary analyses of the social science aspects of international marine resources and to identify and describe the kinds of problems facing ocean regimes and the kinds of research (economic, political science, and legal) that should be undertaken to help resolve the problems. The results are being used as a guide for the development of a program of studies by Resources for the Future, Inc.

SUPPORTED BY Resources For The Future Incorporated

10.0002, SURVEY OF MAINE LAW AFFECTING MARINE DEVELOPMENT

D.J. HALPERIN, Univ. of Maine, Graduate School, *Orono, Maine* 04473

The University of Maine Law School will make a complete survey of all statutes, court decisions, administrative regulations, and policies of the State of Maine which affect marine resource development, and will examine their scientific validity and economic impact. The study will be directed from the Law School, but will involve experts in the sciences and economics from other institutions, including the State Department of Sea and Shore Fisheries. The inter-disciplinary team will relate the laws and regulations to conservation, health, and the economic well-being of the state, will determine the extent to which the laws and regulations are observed, and will determine what major gaps exist in the legal structure insofar as the state's ability to utilize its resources is concerned. The initial step will be to survey the legal structure in detail. This is a prototype legal study which should produce a methodology as well as results useful in Maine.

SUPPORTED BY U.S. National Science Foundation

10.0003, AN ANALYSIS OF THE LAW OF THE CONTINENTAL SHELF AND OF THE RESOURCES OF THE DEEP SEA FLOOR

L.F. GOLDIE, Rutgers The State University, Graduate School, *New Brunswick, New Jersey* 08903

The law of the sea is undergoing increasingly intense scrutiny as a growing technology expands the possibility for developing undersea minerals. On the Continental Shelf, oil and gas exploitation is taking place in deeper and deeper waters. Beyond the edge of the Shelf, increasing attention is being paid to the possibilities for the commercial development of mineral resources of the sea floor. Current law, however, does not define the edge of the Continental Shelf nor the limits to which a coastal state can claim exclusive rights. Nor are there any rules at present that would govern the acquisition of exclusive rights to the sea floor and the exploitation of deep sea minerals. Considerable debate is underway in both national and international forums, but there has been extremely little scholarly study of alternative rules and legal regimes which might be adopted for the orderly development of marine resources.

The study will survey international law in the light of the emerging problems associated with the development of minerals in the continental shelf and deep seabed. The study will bring together the pertinent legal doctrines and concepts; analyze the economic, technological, and social changes that are occurring; and suggest and evaluate alternative regimes that can accommodate these changes within the framework of international law.

SUPPORTED BY Resources For The Future Incorporated

10.0004, LAW OF THE SEA

L.M. ALEXANDER, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

Study conferences on the law of the sea are being held to clarify concepts underlying national and international laws and agreements, to identify problems which require scientific research, to explore relationships between existing or future laws and the development and use of ocean resources, and to examine the implications of various other aspects of the laws.

SUPPORTED BY U.S. Dept. of Defense - Navy

10.0005, INSTITUTIONAL ARRANGEMENTS FOR THE MARINE SCIENCES

A. BARBER, Inst. For Politics & Planning, *Arlington, Virginia* 22209

The study will focus on the question of what changes or innovations in national and international institutions, public and private, are needed to conduct research; develop resources; promote investment; and manage the marine environment in the public interest. Specific tasks include (a) analysis of the effectiveness of existing institutional arrangements for financing and managing multi-national investments in oceanic endeavors; (b) development and analysis of alternative institutional arrangements which might evolve for further encouraging such investments during the 1970's; and (c) recommendation for practical steps for encouraging such investments in the near future to improve existing institutional arrangements, develop new institutions, and modify existing institutions in the context of U.S. national policy objectives.

Specific areas to be considered are fishing; environmental observation, prediction and reporting; and a conceptual basis for multi-national marine investment and management.

SUPPORTED BY Natl. Council on Marine Res. & Engin. Dev.

10.0006, PACIFIC SALMON FISHERIES - ECONOMICS OF MANAGEMENT

J. CRUTCHFIELD, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

The law of the sea is undergoing increasingly intense scrutiny as a growing technology expands the possibility for developing undersea minerals. On the Continental Shelf, oil and gas exploitation is taking place in deeper and deeper waters. Beyond the edge of the shelf, increasing attention is being paid to the possibilities for the commercial development of minerals resources of the sea floor. Current law, however, does not define the edge of the continental shelf nor the limits to which a coastal state can claim exclusive rights. Nor are there any rules at present that would govern the acquisition of exclusive rights to the sea floor and the exploitation of deep sea minerals. Considerable debate is underway in both national and international forums, but there has been extremely little scholarly study of alternative rules and legal regimes which might be adopted for the orderly development of marine resources.

The specific aims of the proposed study are to survey international law in the light of emerging problems associated with the development of minerals in the continental shelf and deep seabed. The study will bring together the pertinent legal doctrines and concepts; analyze the economic, technological, and social changes that are occurring; and suggest and evaluate alternative regimes that can accommodate these changes within the framework of international law. The study will require library research, consultation with social scientists, and research on various international organizations, particularly the International Telecommunications Union and the International Atomic Energy Agency. The results of the study will be reported and published in a suitable form.

SUPPORTED BY Resources For The Future Incorporated

11. EDUCATION AND TRAINING

(educational Programs and Courses; Manpower Training; CommitteeSupport; Publications)

11.0001, A SYMPOSIUM ENTITLED ORGANIC CHEMISTRY OF NATURAL WATERS

D.W. HOOD, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

A symposium entitled 'Organic Chemistry of Natural Waters' was held at the University of Alaska in College, Alaska, September 4-6, 1967. The program included a keynote address by Dr. T. Parsons on Importance and General Implications of Organic Matter in Aquatic Environments; a session on Dissolved Organic Matter Distribution in Natural Waters and Sediments chaired by Dr. E. K. Duursma; a session on Biological Production and Utilization of Organic Matter in Natural Waters chaired by Dr. Mary Belle Allen; a session on Organic Matter and Water Quality chaired by Dr. Douglas Worf; a session on Inorganic- Organic Associations in Natural Waters chaired by Dr. Francis Richards; and a panel discussion on special problems with organic matter in Polar and Sub-Polar waters. In all, 27 of the world's outstanding experts on organic matter will present papers and a total of about 100 participants in the symposium are expected. The proceedings will be published as a monograph from the Institute of Marine Science, University of Alaska.

SUPPORTED BY U.S. National Science Foundation

11.0002, GRADUATE SUMMER RESEARCH PROGRAMS IN EXPERIMENTAL EMBRYOLOGY

H.E. LEHMAN, Bermuda Biolog. Sta. For Res. , *Saint George, Bermuda*

The program is approximately seven weeks duration during the summer, beginning the second week of June and extending through the third week of July. The first four weeks are spent in the introduction of standard embryological methods for handling a wide variety of marine embryonic materials. Emphasis is upon experimental methods and techniques for the study of fertilization, hybridization, nucleo- cytoplasmic interactions, mechanics of cleavage, embryonic determination, chemo-differentiation, morphogenesis, regeneration and growth. The remaining weeks are spent in carrying out original research on problems of the participants' own choosing. In this period the student is given as complete freedom as possible to design experiments within the limitations of time, materials and equipment available at the laboratory.

The Bermuda Biological Station is exceptionally well situated for such a program since a large number of marine embryonic materials, some of which are not available elsewhere, may be collected readily in the surrounding waters. The program will be permitted to use one of the Station's boats and items of underwater swimming equipment in order to carry out its own collection activities. The students will, therefore, receive some additional experience in general marine biology via their observations of reef communities from which experimental materials will be derived.

SUPPORTED BY U.S. National Science Foundation

11.0003, RESEARCH TRAINING IN MARINE BIOLOGY, PALEONTOLOGY AND SYSTEMATIC ZOOLOGY

E.H. SMITH, Univ. of The Pacific, Graduate School, *Dillon Beach, California* 94929

For the past seventeen years, the University of the Pacific has conducted a summer program in marine biology at Dillon Beach, Tomales Bay, California. Although the kinds of courses offered over the years have included marine paleontology, oceanography, marine ecology, ichyhyology, etc., the prime focus has been directed to invertebrate zoology. Of the 248 students who have participated in the invertebrate course since 1951, more than 55 are now in the advanced stages of their doctoral programs, and at least 15 hold academic appointments.

Courses now run for a seven-week period with the latter part of the program devoted to individual research projects. grant provided ten predoctoral stipends for summer of 1968. The students selected came from widely separated geographical areas. The requirement for a summer of resident study or research at a marine station is being applied at many inland universities to candidates for advanced degrees in Biology, Paleontology, and Zoology.

SUPPORTED BY U.S. National Science Foundation

11.0004, SHIPBOARD WORK ABOARD THE OCEANOGRAPHER

O.L. BANDY, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

This support is for funds for travel from Los Angeles, California to Wellington, New Zealand, via Hong Kong, and from Valparaiso, Chile to Los Angeles. This funding is needed primarily for Robert L. Fleisher, graduate student in micropaleontology, to participate in the Wellington-Valparaiso leg of the current cruise of the OCEANOGRAPHER. By arranging to go to Wellington via Hong Kong, it will be possible for Mr. Fleisher, who is a graduate student of the principal investigator, to cooperate in some shipboard work with the staff of Dr. Eggleston of the Fisheries Research Station, Aberdeen, Hong Kong.

SUPPORTED BY U.S. National Science Foundation

11.0005, STANFORD BIOLOGICAL OCEANOGRAPHY

M. GILMARTIN, Stanford University, Hopkins Marine Laboratory, *Pacific Grove, California* 93950

The Stanford Program in Biological Oceanography represents an educational/research approach to: 2) the development of broadly trained biological oceanographers, and, b) the introduction of students in marine biology to biological oceanographic research and techniques; combined with an active research program in biological oceanography.

The program is based on four 12-week cruises per year, with the scientific party for each cruise composed of three senior scientists (faculty) and ten junior scientists (graduate students) form nation wide universities. The seniro scientists give lectures, lead seminars, and supervise the field and laboratory activities of the junior scientists. Both the senior and junior scientists pursue their own research interests concurrently with the basic program. Student participation represents registration in Biology 222H, a 15-unit graduate level course offered by the Hopkins Marine Station.

During fiscal 1968, one cruise was donducted in the Gulf of California, two cruises in the equatorial current system and the Galapagos Islands, and one cruise in the in-shore waters of northern South America and Central America. During these cruises research was conducted on various aspects of the ecology of zooplankton and phytoplankton communities including primary productivity, the physiological ecology and distributional aspects of shallow water benthic communities, the physiology of deep water zooplankton, the community structure and distribution of certain mid-water fishes.

SUPPORTED BY U.S. National Science Foundation

11. EDUCATION AND TRAINING

11.0006, APPLIED MARINE ENGINEERING PROGRAM AT SCRIPPS INSTITUTION OF OCEANOGRAPHY

W.A. NIERENBERG, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

Scripps Institution of Oceanography will initiate a graduate research and education program in applied marine science and engineering. The new applied program will involve the Departments of Earth Sciences, Marine Biology and Oceanography, with engineering support from the Departments of Engineering, University of California at San Diego. The program will initiate activities in such fields as support of ocean industry in the concept, research and design of transport, harbors, mining production, recreational facilities, beach control, fisheries and disposal; and development of the technological base in delination and appraisal of marine resources; analysis of limiting conditions, currents, effects of organisms on man-made structures, etc.

SUPPORTED BY U.S. National Science Foundation

11.0007, OCEANOGRAPHY STUDY ACTIVITIES

F.N. SPIESS, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038 (N00014-67-A-0109-0009)

This work unit provides the scientific expertise of the Marine Physical Laboratory staff to various scientific and technical committees.

The aim of these activities is to make available to the Navy and other appropriate agencies the knowledge and imagination of the members of the MPL staff. This is done through membership on committees of various types. Actual work other than attendance at meetings includes writing of special studies and reports and occasional conduct of some initial probing experiments.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0008, AMERICAN TABLES COMMITTEE FOR THE NAPLES ZOOLOGICAL STATION

J.R. OLIVE, Amer. Inst. of Biolog. Sci. , *Washington, District of Columbia*

The Naples Zoological Station, Naples, Italy, has a uniquely distinguished past in its contribution to the progress of the life sciences. To scientists from many lands, subsidized by their own countries, the Station has become a focus for the practice and display of an international cooperative spirit. Outstanding biologists are afforded a conducive climate in which the exchange of ideas and information may occur through unrestricted research in general and experimental biology. The program is administered through a series of 'working tables,' which is operationally defined as a working space for scientists from a given country for varying lengths of time; each table providing for all costs of actual research work at the Laboratory, including services and materials.

The American Tables Committee is now reviewing applicants for laboratory space at the Station. As it is supported in large measure by various institutions throughout the world, the United States (NSF) has supported the Station in recent years by buying these 'tables.' The Tables Committee of the American Institute of Biological Sciences, sponsored by a grant from the National Science Foundation, accepts and reviews applications and makes selections of scientists.

SUPPORTED BY U.S. National Science Foundation

11.0009, RESEARCH PANELS IN MARINE BIOLOGY

J.R. OLIVE, Amer. Inst. of Biolog. Sci. , *Washington, District of Columbia* (NONR)

The American Institute of Biological Sciences is providing the Navy with essential services.

A cadre of biologists has been developed over the years, who are not only experts in their own specialties, but who are knowledgeable in related matters of concern to the Navy. These biologists are providing information on the state-of-the-art of specific problem areas, pointing out gaps in our knowledge, and suggesting effective approaches to solutions.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0010, ARCTIC FIELD RESEARCH

R.A. FAYLOR, Arctic Inst of North America, *Washington, District of Columbia*

The contractor submits annually to the Office of Naval Research a broad, diverse program of scientific research to be carried out in the Arctic, especially at the Naval Arctic Research Laboratory, and is responsible for execution of such laboratory and field tasks as are approved by ONR. The contractor also organizes symposia, advisory panels and prepares necessary reference work such as the Arctic Bibliography. Invaluable liaison is maintained between the available pool of national and international scientific talent and the facilities and opportunities of the Naval Arctic Research Laboratory. The development and coordination of the research program provides basic information in the fields of glaciology, geomorphology, physiology, ecology, geology, oceanography, micrometeorology, geophysics, marine biology, botany and pedology within the arctic environment.

Invesitgations supported by this task provide the Navy with new and accurate information on arctic and subarctic environments and their effects on man, material and operations. It is clearly advantageous to the Navy and others to acquire all possible information on Arctic environment and its effect on physical and biological processes, especially on human activities.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0011, ARCTIC FIELD RESEARCH

R.C. FAYLOR, Arctic Inst of North America, *Washington, District of Columbia* (NONR-3996(01))

The contract will provide continued effort in research, advisory panels, reference work and publication of the Arctic Bibliography. This work commenced in 1947. Funding is provided by U.S., and Canadian government agencies and private sources.

This publication has provided abstracts of publications prior to 1964. In the last few volumes Russian publications are most mumerous, amounting to about 40% of the material. A substantial amount of the material concerns oceanography and geophysics. The bibliography is one valuable source of Soviet research in The Arctic Ocean Basin. It is clearly advantageous to the Navy and other branches of DoD to acquire all possible information on the Arctic environment and its effect on physical and biological processes.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0012, ARCTIC ADVISORY SERVICE

R.C. FAYLOR, Arctic Inst of North America, *Washington, District of Columbia* (NONR)

Reference work, including compilation of special purpose bibliographies and literature reviews is being accomplished and the product combined with expert knowledge and advice of a large number of consultants, in furnished to NOL as background and guidance in arctic investigations and operations. In addition, NOL has subcontracted to the University of Kansas and McGill University for discrete studies in Sea Ice Physics and Thickness Measurements.

This Work Unit assists NOL with the planning of Arctic research and its applications. Through its available manpower and library resources the contractor is able to provide historical as well as current knowledge of considerable importance and relevance to the Navy with special reference to (a) sea ice physics, (b) sea ice thickness measurements and (c) safety of low-flying aircraft over snow and ice surfaces.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0013, ARCTIC BIBLIOGRAPHY PROJECT

M. MARTNA, Arctic Inst of North America, *Washington, District of Columbia* (AT(30-1)-2797)
STANKA

The Arctic Bibliography provides a key to scientific publications available in the principal libraries throughout the world, relating to the Arctic and Subarctic and to low temperature conditions. Volume 14 assembles over 8,500 abstracts of scientific publications mostly of the period 1962 to 1965 and makes this large compilation available to all who are concerned with the problems of northern research development. Subjects covered include geology meteorology, oceanography, geophysics, and the basic biological sciences, as well as the social sciences and humanities, engineering, mining, fisheries, etc. Administration, native populations, economic conditions, public health and welfare have special attention. All parts of northern Eurasia and North America are represented. Publications are listed by author, the foreign titles with an English translation; all abstracts are in English, and a detailed subject-geographic index is added. The Bibliography is compiled by the Arctic Institute of North America. Volumes 1-12 in this series were published by the United States Government Printing Office, Vol. 13-14 by the McGill University Press, Montreal.

The Arctic Bibliography has become over the years a standard reference work and continues to be required by major libraries and research institutions as well as individual scholars investigating in these and other underdeveloped areas.

SUPPORTED BY U.S. Atomic Energy Commission

11.0014, HANDBOOK OF MARINE TECHNOLOGY
UNKNOWN, Marine Technology Society Inc. , *Washington, District of Columbia* (N00014-66-C0158)

The Editorial Board and Technical Review Teams are presently reviewing selected material for inclusion in the Handbook of Marine Technology. The handbook will include standardized reference tables, graphs, constants, monograms, etc. covering the fields of physical oceanography, chemical oceanography, biological oceanography, geological oceanography, marine meteorology, ocean engineering and diving.

This handbook will be pertinent to the design of oceanographic acquisition systems, deep submergence systems, and man-in-the-sea programs.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0015, WORKSHOP ON EFFECTS OF ATOMIC RADIATION ON OCEANOGRAPHY
A.H. SEYMOUR, Natl. Academy of Sciences, *Washington, District of Columbia*

The purpose of the Workshop is to update NAS Pub. 551 concerning the effects of atomic radiation on oceanography and fisheries by bringing together approximately 35 scientists from many different fields to resolve apparent divergencies in the publication and identify and fill in missing elements.

Outline prepared. Participants selected and assignments made for preliminary work.

SUPPORTED BY U.S. Atomic Energy Commission

11.0016, COMMITTEE ON OCEANOGRAPHY
R.C. VETTER, Natl. Academy of Sciences, *Washington, District of Columbia* (NONR)

The Committee on Oceanography was organized in 1957 to assist government agencies on a multitude of problems, ranging from the effects of radioactivity on the marine environment to the planning of long range scientific studies of the oceans. The Committee has recently been reorganized under the chairmanship of Dr. John C. Calhoun, Jr. During the year ahead, the Committee expects to focus on the attack of scientific problems as well as management problems that effect our ability to conduct oceanographic research. The scientific problems to be emphasized are expected to include: scales of motion in the oceans, geotectonics, matter in the ocean, models of marine ecological systems, and air-sea interrelationships. Attention also will be given to development of the National Oceanographic Program.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0017, UNDERGRADUATE RESEARCH PARTICIPATION
I.E. WALLEN, Smithsonian Institution, *Washington, District of Columbia* 20560

It is proposed that the Smithsonian Institution provide training in the biological sciences for 25 undergraduates from colleges and universities in the United States during the summer of 1967 and the academic year 1967-68. Within the Institution's Museum of Natural History, Oceanographic Sorting Center, the National Zoological Park, Radiation Biology Laboratory, and Tropical Research Institute, students will spend either ten weeks during the summer or, in the case of students at colleges and universities having work-study programs or quarter systems, ten weeks during the academic year carrying out research projects under the supervision of senior scientific staff members.

SUPPORTED BY U.S. National Science Foundation

11.0018, MARINE SCIENCE STUDIES
I.E. WALLEN, Smithsonian Institution, *Washington, District of Columbia* 20560 (N00014-67-A-0399-0002)

The purpose of this task is to provide for the planning, organizing and conduct of scientific conferences as requested by the scientific officer. Written reports shall be furnished at the conclusion of each study.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0019, SECOND AND FOURTH ANNUAL EDWIN A. LINK LECTURES
I.E. WALLEN, Smithsonian Institution, *Washington, District of Columbia* 20560

Funds were requested for the Second (1965), the Fourth (1967), and the Sixth (1969) Edwin A. Link Lectures. Alternatively in Oceanography and in Space Sciences these lectures are given in honor of Mr. Link, Inventor, Industrialist, and Philanthropost.

SUPPORTED BY Link Foundation

11.0020, PUBLICATION OF OPPORTUNITIES IN OCEANOGRAPHY
I.E. WALLEN, Smithsonian Institution, *Washington, District of Columbia* 20560

Originally published with funds from the Link Foundation and the Naval Oceanographic Office, the money from sales of the booklet are retained for use in publishing revised manuscripts.

SUPPORTED BY Smithsonian Institution

11.0021, CONSULTATIVE AND ADVISORY SERVICES - BATTERY PROBLEMS
W.J. HAMER, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia*

Technical Objective: To provide authoritative advice.

February 1967 - December 1967: Advice on battery problems was given during the year to United Aircraft, USASI, International Nickel, General Services Administration, Battelle Memorial Institute, Federal Trade Commission, Union Carbide, Securities and Exchange Commission, K & W Batteries, Patent Office, Naval Research Laboratory, and Senator Hart. Advice on measurements and data related to standard cells was given during the year to the editor of Measurements and Data, to ITT of Florida, to Department of Chemistry of Purdue University, Industrial Research Institute, Irvin P. Stern Associates, BIPM, Dr. Froelich of PTB, L & N, Nortronics, Sandia, Lawrence Radiation Laboratory, Boston College, Dr. Hetzel of PTB. Lectures were given to various groups touring the standard cell laboratory.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

11.0022, INCREASE EFFICIENCY OF HAWAIIAN LONGLINE FISHERY
T.S. HIDA, U.S. Dept. of Interior, Bureau of Comm. Fisheries, *Honolulu, Hawaii* 96812

The Hawaiian longline fishery contributes a substantial part of the needs of the fresh fish market in Hawaii. Although the prices received at the wholesale and retail levels are one of the highest in the State, the fishery, in recent years, has declined in the number of boats active in the fishery and the total catch. Part of the decline is related to the labor-intensive nature of this fishery. The relatively low efficiency of fishing, plus the need for long hours of 'soaking' the gear contributes to a long fishing day.

The present project is designed to seek means of increasing the efficiency of this method of fishing. The financial returns to the fishermen could be increased by (1) mechanizing parts of the longline fishing operation, thus permitting more units of gear to be fished, (2) locating new areas of good fishing, and (3) seeking alternate fishery resources to harvest during periods of low availability of the large -size tunas in Hawaiian waters. Much of the effort in this project would be devoted to keeping industry informed of foreign developments in gear research and fishing success in waters within range of the Hawaiian fishing fleet.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

11.0023, STATUS OF OCEANOGRAPHIC EDUCATION AT PRE-COLLEGE LEVEL

R.H. CHARLIER, Northeastern Ill. State Coll. , Graduate School, *Chicago, Illinois* 60625

Follow-up Work: Prepare a 'unit' teacher and students manual for use in pre-college situations. Originally support interest was shown by National Youth Science Foundation but no further word received since March '68.

Study place of Marine Sciences in pre-college science curriculum. Prepare teachers, not planning to become oceanographers, to familiarize themselves with oceanology.

Investigate interest and reactions of students to marine sciences. Articulate a high school/college/graduate school program.

SUPPORTED BY No Formal Support Reported

11.0024, MARINE LABORATORY

J.G. BROOM, State Wildlife & Fish Comm. , *New Orleans, Louisiana*

This project area incorporates all six of the previous described phase areas, namely coastal Louisiana. Here, the project leader will compile, analyze and interpret the data. It is proposed that different types of nets and sampling devices will be developed and evaluated for use in these situations as the need arises as determined by the project leader. Additionally methods and gear used successfully in other areas will be evaluated for application here.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Louisiana State Government

11.0025, BIOLOGICAL INVESTIGATIONS WITH ISOTOPES

J.A. HELLEBUST, Harvard University, Graduate School, *Cambridge, Massachusetts* 02138

This grant will be used to maintain and improve the usefulness of the central isotope facilities shared by the faculty and students of the Biological Laboratories. The utilization of instruments and isotope facilities, under the direction of Mr. Edward Lenhoff, avoids unnecessary duplication of expensive equipment and provides greater safety.

A large number of current and proposed research projects of departmental professors and staff members vitally depend upon our centralized isotope facilities. These projects range from investigations in molecular biology to ecological studies on marine algae.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

11.0026, TECHNICAL ASSISTANCE AND LIAISON WITH FISHING INDUSTRIES

R.A. BRUCE, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, *Gloucester, Massachusetts* 01930

The primary purpose of this project is to benefit the fishing industry through increasing and maintaining Bureau-Industry contact. In part, to achieve this objective, Base personnel use specialized instrumentation devices aboard commercial fishing vessels to improve the effectiveness of fishing gear being used. Other commonly used devices to achieve this end are (1) Bureau supervision of the use of new or unfamiliar gear, (2) personal attention to inquiries on gear or fishing problems by the individual industry member, and (3) timely reporting and/or relay of useful information gathered from sources outside of the Bureau.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

11.0027, INVESTIGATIONS IN MARINE BIOLOGY

P.B. ARMSTRONG, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

This grant supported general research activities of the instructional associated with the summer courses in marine biology staff/at the Marine Biological Laboratory.

SUPPORTED BY U.S. National Science Foundation

11.0028, SUPPORT OF TRAINING PROGRAMS IN INVERTEBRATE ZOOLOGY AND MARINE BOTANY

H.B. STEINBACH, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

The Marine Botany course, now designated Experimental Biology, has been reorganized to stimulate an informed interest in some of the most recent concepts and techniques in the botanical sciences and at the same time to direct that interest towards unsolved problems in the biology of marine plants. The Instructor-in-Charge, Dr. William S. Hillman, has four additional instructors to guide the students in Botany. The Invertebrate Zoology course is conducted by Dr. W. D. Russell Hunter aided by a staff of seven instructors. This permits each staff member to confine his attention to a single group of invertebrates and thus it provides a depth of experience and knowledge of that particular group. The purposes of these courses, as well as all research training courses at MBL, are to produce research investigators as well as initiate investigations into the marine environment.

The courses are made up of outstanding students from many universities. Opportunities are provided to meet active investigators in various fields of research from all parts of the country as well as participating in seminars, formal discussions and meetings. The number of highly qualified applicants has been nearly two to three times the available space for the students. First consideration has been given to persons who appear likely to contribute to the advancement of biology. Past experience has justified this mode of selection.

SUPPORTED BY U.S. National Science Foundation

11.0029, RADIOBIOLOGICAL RESEARCH ON MARINE ORGANISMS

H.B. STEINBACH, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

This grant will provide support for the radiobiological facilities used by about one hundred and twenty investigators in the conduct of their research projects during the summer of 1968. These investigators will be selected on the basis of their projects and their requirements for the facilities and biological materials available at the Marine Biological Laboratory.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

11.0030, SUPPORT FOR THE OPERATION OF OCEANOGRAPHIC RESEARCH VESSELS

P.M. FYE, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543

This project provides approximately 50% of the costs of operating the WHOI vessels ATLANTIS II, CHAIN, CRAWFORD AND GOSNOLD. Shiptime requirements for NSF supported research is thus provided in a ratio of 43% for biological work and 57% for physical sciences. The biological portion also includes $51,242 for travel of biologists to and from research vessels. The total for DES is $616,380 and for BMS $522,600.

The above mentioned research vessels will be engaged in a broad multi-disciplinary program of oceanographic research during the fall of 1967 and during 1968. Programs include studies of the Gulf Stream: biological studies in the North Atlantic, the tropical Atlantic, and the South Atlantic; heat-flow, gravity and magnetic investigations in the Caribbean; sound transmission and geophysical studies in the northeastern Atlantic, and other programs.

SUPPORTED BY U.S. National Science Foundation

11.0031, WOODS HOLE STUDY ACTIVITIES
E.E. HAYS, Woods Hole Oceanographic Inst. , *Woods Hole, Massachusetts* 02543 (NONR)

Objective: Provide services on acoustic propagation and oceanography to Naval technical committees seeking answers to operational problems or attempting to define the state of the art of equipment design, and to provide similar services to the oceanographic scientific community by participating in meetings, symposia, and working groups.

Approach: Provide the Navy with specific answers from available oceanographic data in response to specific requests; serve on committees and working groups on oceanographic and marine engineering problems for the Navy; maintain a liaison between the oceanographic scientific community and the seagoing forces of the Navy so that full use can be made of the oceanographic information.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0032, SPECTRAL ANALYSIS
W. MARKS, Oceanics Incorporated, *Hicksville - Plainview, New York* 11803 (NONR)

A handbook on the application of spectral techniques to the study of oceanographic and other geophysical phenomena is being developed. A series of prescribed spectra have been derived and are being analyzed to determine the effects of various analysis parameters, such as spectral windows, length of records, etc.

The results of this effort should contribute to the design of environmental data collection systems which may be used to provide information for operational oceanographic forecasts.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0033, SUPPORT OF THE MARINE BIOLOGY PROGRAM AT THE LAMONT GEOLOGICAL OBSERVATORY
P.R. BURKHOLDER, Columbia University, Graduate School, *New York, New York* 10027

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY G. Unger Vetlesen Foundation

11.0034, CONFERENCE REPORTS
F. FREMONTSMITH, New York Academy of Sciences, *New York, New York*

The New York Academy of Sciences will provide this Office with copies of the proceedings of the biology conferences which were held under Contract Nonr 4592(00), NR 104-838. The proceedings are in book form and are being distributed in accordance with the directives of this Office. These conferences are part of a series presented by the Academy and follow the pattern of the well-known interdisciplinary conferences sponsored by the Josiah Macy, Jr. Foundation. The volumes will consist of an approximately verbatim record of the discussions of a small selected group of recognized experts on the problem which is the topic of the conference - no formal papers are presented. The controversial tone and the informal expression of opinion are essential to the achievement of a thorough and well rounded review of the subject and usually brings out unorthodox insights and approaches. The use of this method has in the past been particularly effective in developing mutual understanding and basis for planned topics, which include ecological, as well as cellular studies.

The distribution of these proceedings, among current and potential ONR investigators and among program managers and scientists in ONR and the Navy bureaus, will aid tremendously in coordination of research and of research programs, especially where biological knowledge and viewpoints impinge on such others as engineering, physics, and geophysics.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0035, BIOLOGY CONFERENCE SERIES
F. FREMONTSMITH, New York Academy of Sciences, *New York, New York*

The New York Academy of Sciences through its Interdisciplinary Communications Program, is conducting a series of conferences in a variety of biological disciplines of special interest to the Navy. The conferences will be devoted to subjects directly or indirectly contributing to the Hydrobiology, Ecology, and Biological Orientation Programs of this Office. A diversity of conference subjects has been selected for the series in order to focus attention on aspects of the various research studies where true advances are being made, where promising trends appear to be developing, and where disciplines of the Biological Sciences are involved.

During the proposed conferences, the state-of-the-art in a wide spectrum of biological research and Naval relevance will be discussed by a selected group of internationally prominent scientists. The resulting published proceedings of the conferences will be made available to appropriate addresses on the ONR distribution list and to appropriate program managers and scientists within and also outside the Department of the Navy. These publications will aid, not only the scientific community per se, but in addition will aid in the coordination of research and of research programs, especially where life sciences knowledge and view points impinge on those of the physical sciences.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0036, AN ENLARGED PROGRAM OF RESEARCH IN NEW LABORATORIES OF MAINE SCIENCES
UNKNOWN, New York Zoological Society, *New York, New York*

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Rockefeller Foundation

11.0037, COOPERATIVE RESEARCH AND TRAINING PROGRAM IN BIOLOGICAL OCEANOGRAPHY
C.G. BOOKHOUT, Duke University, Graduate School, *Beaufort, North Carolina* 28516

This grant will support a program of training and research in biologival oceanography associated with the R/V EASTWARD at Duke University Marine Laboratory. Major aspects of this program include graduate traineeships and postodoctoral awards in biological oceanography, advanced seminars in oceanography, and training and research projects aboard the R/V EASTWARD. In March of each year a five-man Project and Program Review Committee composed of nationally recognized oceanographers meets to review research projects, and to select graduate trainees and post doctoral recipients.

This year the Committee approved a shipboard program of 279 days for the R/V EASTWARD. When these days were combined into programs of similar research, a schedule of 237 planned days at sea evolved. Twenty-three institutions are involved in the research and training programs during FY 69. Also included in the program is a 90-day cruise into the Caribbean Sea in which 11 institutions are participating.

The success of this program is measured not only by the improved caliber of applicants and substantially increased requests for shiptime, but especially by the large number of resultant publications and the fine, well trained graduates.

SUPPORTED BY U.S. National Science Foundation

11.0038, RESEARCH AND TRAINING IN MARINE BIOLOGY
C.G. BOOKHOUT, Duke University, Graduate School, *Beaufort, North Carolina* 28516

The grant provides support for predoctoral and postdoctoral awards in marine biology at the Duke University Marine Laboratory.

The purpose of the predoctoral award is to make it financially feasible for a qualified graduate student from any university in the U. S. to receive training and do research in marine biology at the Duke University Marine Laboratory. All applications for the award are reviewed independently by 5 referees, only on of whom is from Duke University. Twenty-one awards are given to graduate students who received the highest ratings. The award is for a period of five weeks in the summer.

The program also includes two predoctoral awards. These are available on a competitive basis. A faculty member from any college or university , exclusive of Duke University, may apply. Selections are made on the basis of the quality of the research proposal and whether the facilities of a marine laboratory are actually needed to do the research. The award is for a period of 12 weeks, and can be held at any time during the year.

SUPPORTED BY U.S. National Science Foundation

11.0039, STUDENT RESEARCH AT THE MARINE SCIENCE CENTER

J.W. HEDGPETH, Oregon State University, Marine Science Center, *Newport, Oregon* 97365

This project provides for support of students primarily during the summer, but also during other times of the year to undertake small research projects as part of their training experience in marine biology. Emphasis in the individual projects is on ecology and physiology of intertidal and near shore invertebrates of the Oregon coast. Principal Investigator is Joel W. Hedgpeth assisted by resident and visiting staff.

SUPPORTED BY U.S. National Science Foundation

11.0040, SYMPOSIUM ON RESEARCH NEEDS AND PRIORITIES FOR MARINE GEOLOGY OF THE GULF OF MEXICO

J.C. CALHOUN, Gulf Universities Res. Corp. , *College Station, Texas*

It is planned to hold a 3-1/2 day symposium to determine research needs and priorities for marine geology, with particular reference to the Gulf of Mexico. There is considerable need for analysis and program planning in marine geology not only with respect to geological research in general but also with respect to oceanographic research and to the development of marine resources. The Gulf of Mexico is one of the world's best examples of a nearshore oceanic environment wherein present-day events provide a model for past marine geologic events, and, in addition, is one of the more extensive shelf areas surrounding U. S. shores making it particularly attractive geologically because of its high potential mineral resource value. The Gulf therefore is an especially logical area of focus for the proposed symposium.

Suggested topics of symposium discussion include: sedimentation and sedimentation processes; relationships between marine geology and marine ecology; geophysics and geologic structure of the Gulf; facilities for serving marine geolgy research; engineering properties of ocean sediments; and instrumentation. Approximately 30 participants will be brought together for the planned symposium. It is expected that there will be a report of findings including the identification of key scientific efforts that are needed, the approach to achieving solutions to the problems identified, magnitudes of effort required, priorities, and identification of those efforts of current opportunity in the Gulf of Mexico.

SUPPORTED BY U.S. National Science Foundation

11.0041, REPORT DISTRIBUTION

C.S. SAYCE, State Dept. of Fisheries, *Olympia, Washington*

The objective of this phase is to record all data in usable form and distribute timely information about the time and intensities of impending oyster spatfalls to local members of the industry for their use in preparing to clutch for spatfalls. This will be done by means of a weekly bulletin distributed to industry and other interested laboratories. Results of research in oyster seed investigations and oyster fatness experiments will be reported to the contracting agency.

Part 3 of 3.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

11.0042, A TRAINING PROGRAM FOR GRADUATE STUDENTS IN MARINE SCIENCES AT THE FRIDAY HARBOR LABORATORIES

R.L. FERNALD, Univ. of Washington, Friday Harbor Laboratories, *Seattle, Woshington* 98105

The grants were requested and have been used to provide limited financial assistance to qualified graduate students for training in all areas of marine sciences represented by formal courses of instruction and by research activity and supervision at the Friday Harbor Laboratories, the marine biological laboratory of the University of Washington. Facilities for year round investigation and study have been developed at the Laboratories and efforts have been made to increase the use of these facilities at times other than summer. Advanced graduate students from a number of different universities have taken advantage of the opportunity to remove seasonal limitation from marine investigations and have been able to carry out year round studies. Formal courses offering research training are offered in the Spring and Summer Quarters of the year. No geographic restrictions have been imposed in the award of these grants-in-aid to qualified graduate students. The merit of their individual program has been the important criterion for determining the question of support.

SUPPORTED BY U.S. National Science Foundation

12. FACILITIES

(ship and Laboratory Support)

12.0001, RESEARCH-TRAINING COURSE IN OCEANOGRAPHY IN SOUTHEAST ALASKA

D.W. HOOD, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

The course was divided into two sessions. The first included courses in General Oceanography (Geology 411, 3 credits) and Chemical Oceanography (Chemistry 641, 3 credits). The second session consisted of student research projects in Chemical Oceanography (Chemistry 642, 3 credits) or Marine Microbiology (Biology 641, 3 credits).

Students attended both courses during the first session, and each student completed a research project and attended conferences in his area of interest during the second. At the beginning of the program, each student selected a research project in conference with the appropriate staff member. During the first session, the student made a research plan, developed techniques, did preliminary field work and formulated plans for accomplishing his research project. The second session was spent gathering laboratory and field data to complete this project. A research report was prepared and presented to the entire group during the last week of the program.

SUPPORTED BY U.S. National Science Foundation

12.0002, LENGTHENING AND INCREASING OCEANOGRAPHIC CAPABILITES OF R/V ACONA

D.W. HOOD, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

The 80-foot R/V ACONA will be lengthened to 100 feet (l.o.a.) in order to (1) permit increase of her scientific complement from eight to eighteen; (2) increase deck working space and (3) more than double existing laboratory space. This modification will require addition of only one crew member and will increase operating costs by less than 10%. Concomitant modifications to improve the research capabilities of the vessel will include increase of power output capacity by replacement of two 15 kw generators with two 40 kw, replace existing winch with less than 2,000 meter-depth capability; installation of a 510 h.p. marine engine to replace the existing 300 h.p. engine; and installation of a ventilated hood in the dry laboratory. Lengthening will be achieved by cutting the vessel in half amidships and adding a 15-foot section and by extending the fantail five feet.

In its present configuration the R/V ACONA will not accommodate scientific parties of sufficient size to conduct 24-hour work on the continental shelf in Gulf of Alaska and along the Aleutian chain. Hence, its operations have been confined to inshore waters and inter- waterway work. Conversion will permit more extended operations during the non-winter months thus extending also the research and training capabilities of the Institute of Marine Science of University of Alaska, the only U. S. oceanographic institution now concerned entirely with the far northern waters of the west coast.

SUPPORTED BY U.S. National Science Foundation

12.0003, ARCTIC RESEARCH LABORATORY

W.R. WOOD, Univ. of Alaska, Graduate School, *College, Alaska* 99735 (NONR-4009(01))

Naval Arctic Research Laboratory (NARL), Barrow, Alaska, provides a base of operations, a laboratory and logistic support in the arctic environment for scientists of government, university and private institutions working under contracts with ONR and other government agencies. Basic research in physical and biological sciences, as well as naval sciences are conducted on the Arctic Slope and in the Arctic Seas through NARL and its 20 field stations, including drifting ice stations in the arctic pack.

Operations and investigations at NARL supply the Navy with new and accurate information on Arctic and sub-Arctic environments and their effects on human activities. Studies include arctic oceanography, geophysics, hydroacoustics and terrain analysis. Personnel trained provide the Navy a pool of manpower with first-hand experience in an area which is unique among oceans where the Navy must operate.

SUPPORTED BY U.S. Dept. of Defense - Navy

12.0004, AQUISITION OF A SUITABLE PROTOTYPE FISHING VESSEL AND GEAR

J.R. HOLLOWAY, Amer. Somoa Dept. of Agric., *Pago Pago - Tutuila, American Samoa*

Objectives: Obtain a fishing vessel of convenient size and maximum flexibility for utilization in exploratory fishing and initial fisheries development phases.

Procedures: The small Hawiian sampan (40 degrees plus or minus) would seem the ideal vessel for the needs of American Samoa, since these beats are regularly used for bottom fishing, setting of crab and lobster nets and live-bait pole-and-line fishing for tunas.

A competent and experienced captain-fisherman will be recruited and with his aid a suitable second hand vessel will be purchased, or chartered in Hawaii readied, and shipped to American Samoa.

Additional gear such as seines, floats, line etc. not available with the vessel will be purchased and shipped with the vessel. Some gear such as fish traps and lobster pots will be fabricated in Samoa by fishery trainees.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
American Samoa Government

12.0005, HUMAN PERFORMANCE IN UNUSUAL ENVIRONMENTS

A.J. BACHRACH, Arizona State University, Graduate School, *Tempe, Arizona* 85281

Objective: The objectives of this group are to establish and operate a facility to investigate man's performance in unusually stressful environments, with emphasis on the underwater environment. This is the environment in which the Navy is tending more and more to operate, with free swimmers and divers.

Approach: Contractor will design, construct, and operate a facility for studying man's performance in controlled underwater environment in which relevant variables are programmed and monitored by means of small computers. Variables to be controlled include depth (to 33 ft), composition of breathing mixture, complexity of work assignment, and degree of subjects isolation.

SUPPORTED BY U.S. Dept. of Defense - Navy

12.0006, MARINE BIOLOGY RESEARCH AT THE BERMUDA BIOLOGICAL STATION

W.H. SUTCLIFFE, Bermuda Biolog. Sta. For Res., *Saint George, Bermuda*

The grant provides support for general research activities of visiting investigators at the Bermuda Biological Station.

SUPPORTED BY U.S. National Science Foundation

12.0007, FEASIBILITY STUDY ON HORIZONTAL TEST TANK FOR MODEL STUDIES AND COMPONENT TESTING

M.J. CRUICKSHANK, U.S. Dept. of Interior, Marine Min. Technol. Ctr., *Belvedere - Tiburon, California* 94920

The need for an experimental test facility for the investigation of mining problems has been shown during the analysis of dredge systems operations. A contract for an architectural and engineering study for such a facility has been let to Tetra Tech Inc., an ocean technology firm, of Pasadena.

The first phase of the program will be to determine configurations for the water tank, test carriage, instrumentation system and adjustable model of beaches and ocean bottoms. The planned facility will be used for a variety of tests including model testing of total systems for wire line dredging, towed hydraulic systems, submerged mining systems, problems related to surf and bottom currents and testing of diver and remote operated equipment.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

12.0008, SUPPORT OF THE RESEARCH VESSEL AHOYOHA III

J. SAVAGE, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

The R/V AHOYOHA III is a 30 ft. Drake style power cruiser constructed of wood with fiberglass coating. At the present time, she is powered with 221-crbic inch interceptor gasoline engines with twin

of Southern California plans to reengine with diesel engines. Navigational equipment includes a Bendix 42 radiotelephone and a Raytheon A-20 echo sounder.

The R/V AHOYOHA III is being used as a vehicle for the in situ measurements and observation of environmental factors by marine biologists and geologists. Because of the nature of this type of research work all investigators are qualified scuba divers. At the present time 14 geology graduate students and faculty, and 20 biological science graduate students and faculty are qualified divers.

The presently recommended grant provides for a year's support of the R/V AYOHOYA. The budget includes the cost of new diesel engines, installation costs of the engines will be borne by the University of Southern California

SUPPORTED BY U.S. National Science Foundation

12.0009, SUPPORT OF THE VERMILION SEA FIELD STATION AT BAHIA DE LOS ANGELES, BAJA CALIFORNIA

R.P. PHILLIPS, San Diego Natural History Mus., *San Diego, California* 92134

This modest bilogical field station is 340 miles southeast of San Diego, in one of the most remarkable desert environments of western America. It is on the west shore of the Gulf of California, in an exceptionally interesting marine area of islands and bays, with varied rocky and sandy habitats to depths of 600 fathoms. The surface waters are subject to great temperature range and tidal amplitude. The diversied flora and fauna are largely of tropical character and have prominent endemic elements. The surrounding terrain is an equally interesting desert, with unusual xerophytes and associated animals.

The station is a 9-room building, just above the high tide line. It has fresh water and electric power. An International Travelall and a 17-foot outboard motorboat are kept there; and other boats, up to an 85-foot motor vessel, are available locally for charter. Good food and accommodations are available at $7.00 per day in the village.

The station is reached in two hours by scheduled flights from Tijuana (round trip approximately $49). The overland route takes three days by truck.

Visiting investigators are invited to use the station. They should be qualified workers with legitimate research projects, and they should be provided with proper collecting permits and other credentials for work in Mexico. Formal request should be made to the Director.

12. FACILITIES

SUPPORTED BY U.S. National Science Foundation

12.0010, PARTIAL SUPPORT OF SHIP OPERATIONS FOR RESEARCH AT SEA ON OCEANOGRAPHY

W.A. NIERENBERG, Univ. of California, Scripps Inst. of Oceanography, *San Diego - La Jolla, California* 92038

This project will provide approximately 38% of the operating costs for the coming year of the following Scripps vessels: R/V AGASSIZ, ARGO, HORIZON, OCONOSTOTA, SCRIPPS, and WASHINGTON. It will also provide funds for purchase of a computer system to be installed aboard the R/V WASHINGTON. It will support virtually all the ship time for Foundation sponsored research. Research to be carried out will cover a wide range of scientific objectives, one-third biological and two- thirds in the other marine sciences. The geographical area covered will be between the North and South American continents and the central Pacific. The longest expedition will be a combination of physical, chemical, geological and biological oceanography. This cruise will center most of its activities between Hawaii, Samoa, and Kwajalein. Currents, various water properties and sediments at abyssal depths and in relation to sea-floor structure are to be collected. Also sampling of the fauna will be carried out throughout the cruise ranging from the near surface, to tops of seamounts and guyots and into the abyssal depths. Other cruises will study ocean currents at the sea floor and their spatial correlation; marine biota of the California Peninsula and Gulf; Post-pleistocene oceanography and biology of the Eastern North Pacific; heat budget of the sea surface; taxonomy, zoogeography and ecology of Pacific zooplankton; tectonic and geological history of the Southwest Pacific Region; and development of deep-sea autonomous instruments.

SUPPORTED BY U.S. National Science Foundation

12.0011, SUPPORT FOR THE PHYSIOLOGICAL RESEARCH SHIP, R/V ALPHA HELIX

P.F. SCHOLANDER, Univ. of California, Graduate School, *San Diego - La Jolla, California* 92038

On July 1, 1967, the floating laboratory 'Alpha Helix' was anchored in Brazil's Rio Negro with Dr. Carroll Williams of Harvard as senior scientist. Fifteen scientific reports ensued. Striking findings were the high content of hormonal insecticides dissolved in the Rio Negro as a result of leaching from the vast, flooded rain forests. Hallucinogens were extracted and preserved from plant material of the genus Virola, used by Amazon Indians, which will form the basis for further studies of its chemical composition.

On August 15, 1967, Dr. Jacob Biale of UCLA took over as senior scientist, with an agronomically slanted program. Twenty reports ensued. Important studies were made on ripening of tropical fruits. It was discovered that root fungi (mycorrhizae) are a general occurrence in the jungle trees. This probably explains how such lush forests can thrive on such mineral-poor soil.

SUPPORTED BY U.S. National Science Foundation

12.0012, PARTICIPATION IN USARP EXPEDITIONS

I.E. WALLEN, Smithsonian Institution, *Washington, District of Columbia* 20560

A cooperative project to continue participation of biological workers from the Smithsonian Institution on Antarctic cruises and expeditions on an opportunity basis within existing logistic arrangements. Participants' salaries will be borne by the sponsoring institution. Transportation from the United States to the port of embarkation will be coordinated through the Smithsonian Institution from funds provided by this proposal. In this way, biological specialists with interests complementing United States Antarctic Research Programs aboard USNS Eltanin, R/V Hero and cruises conducted aboard USGGC ice breakers can assist in biological oceanology activities on a space available basis. To date 31 Smithsonian Institution scientists have taken part in five USNS Eltanin trans-Pacific and South Pacific cruises and the USGGC Eastwind Oceanographic Cruise to the Antarctic Peninsula, 1966. Professional personnel from the Smithsonian Oceanographic Sorting Center have helped in shipboard sorting, cataloging, and preservation of biological collections when University participation was lacking. The SOSC has contributed to improvements in handling of collections and data records aboard ship and in the development of techniques for processing microorganisms, fragile specimens and other biological materials requiring special handling. Support has also been possible for field work in unique areas where the logistic opportunity afforded an extension of biological research without the additional costs for analysis of data and specimens. The Juan Fernandex Island Expedition is a case in point. The plan presented by the Smithsonian Institution in this proposal includes only travel cost for five participants who will cooperate in research aboard USARP ships and on land expeditions.

SUPPORTED BY U.S. National Science Foundation

12.0013, METEOROLOGICAL SUPPORT OF DEEP-SEA DRILLING OPERATIONS

V.D. ROCKNEY, U.S. Dept. of Commerce, Weather Bureau, *Washington, District of Columbia*

The proposed work consists of the providing of meteorological advice in support of the Ocean Sediment Coring Program. In particular, the Proposal is to provide a meteorologist aboard the drilling vessel for which the University of California has planned under the terms of Contract NSF-C482. In drilling operations from a floating vessel in the deep oceans it is regarded as imperative that the master of the vessel and the drilling operations manager on board be provided with meteorological advice. The proposed work will assure both the safety of the vessel, which will operate at times in very remote areas, and wave-forecasting services in order to optimize the several aspects of the drilling operation which are limited by vessel motions. All communications and facsimile reception equipment will be supplied by the University, so the subject Proposal is only for the furnishing of the meteorological personnel.

SUPPORTED BY U.S. National Science Foundation

12.0014, RESEARCH ADVISORY SERVICES

UNKNOWN, U.S. Dept. of Commerce, Maritime Transp. Res. Board, *Washington, District of Columbia*

Description: The Board, and its predecessor, Maritime Cargo Transportation Conference, undertakes investigations of maritime problems in areas where the National Research Council can best provide guidance on means and techniques to improve maritime systems. Co- operative government-industry panel efforts are utilized where such advisory services can best serve the national interests of maritime transportation.

The Maritime Cargo Transportation Conference did extensive exploration and research of cargo handling in the port of San Francisco; unitized cargo techniques for inland and overseas transportation; cargo handling by cranes; burtoning gear, and roll-on roll-off, vessels; and origin to destination systems.

More recent work of the board has been a functional analysis of work performed aboard ship; development of a stepboard system to collect data for management information; and a statistical study of the U.S. Merchant Marine work force including employment qualifications, union- company affiliations, age, length of service, attrition work opportunity, and retirement trends.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

12.0015, SYSTEMS ANALYSIS ASSISTANCE TO HEADQUATERS U. S. COAST GUARD

E.E. HOWE, U.S. Dept. of Transportation, Coast Guard, *Washington, District of Columbia* 20591

The objective of this project is to provide a systems analysis capability for the Coast Guard Headquarters in establishing their position relative to icebreakers and their use in the decade ahead. The approach is to assist in problem structuring drawing on such techniques as cost-benefit analysis, mission definition and analysis, use of relevance tree and economic modelling.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

12.0016, SUPPORT OF THE NATIONAL OCEANOGRAPHIC DATA CENTER

L.E. DECAMP, U.S. Navy, Natl. Oceanographic Data Ctr. , *Washington, District of Columbia*

Established by an Interagency Agreement dated 23 December 1960, the National Oceanographic Data Center is administered by the U. S. Naval Oceanographic Office and is jointly supported by the Navy, the Atomic Energy Commission, the U. S. Weather Bureau, the Coast and Geodetic Survey, the Bureau of Commercial Fisheries, the Geological Survey, the U. S. Coast Guard, and the National Science Foundation.

Its function is to collect, compile, store and disseminate oceanographic data, serving the entire scientific community. Its advisory board, composed of representatives from each of the sponsoring agencies, advises on plans and policies.

SUPPORTED BY U.S. National Science Foundation

12.0017, SUPPORT OF THE NATIONAL OCEANOGRAPHIC DATA CENTER

W.C. JACOBS, U.S. Navy, Hydrographic Office, *Washington, District of Columbia*

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY U.S. Atomic Energy Commission

12.0018, SUPPORT OF WORLD DATA CENTER - A (OCEANOGRAPHY)

W.C. JACOBS, U.S. Navy, Oceanographic Office, *Washington, District of Columbia*

This grant will support the administration and operation of World Data Center A, Oceanography, required by international commitments; which have not been provided for in the regular NODC budget or elsewhere. The functions of this center include: acquisition of data; exchange of data; compilation, preparation, printing and distribution of semiannual catalogues of data, track charts of catalogued cruises, bibliographies of publications, special data lists, related charts, information for international commissions, committees and expeditions and development of improved methods to prepare and issue up-to-date catalogues of data and related information.

SUPPORTED BY U.S. National Science Foundation

12.0019, UNDERWATER ACOUSTICS MEASUREMENTS FACILITY

J. KINGSBURY, U.S. Navy, Ship Systems Command, *Washington, District of Columbia* 20360

Objective: To develop a acoustic facility at USL for the purpose of performing underwater acoustic measurements under controlled conditions.

Approach: It is clear that certain aspects of acoustic propagation are not entirely understood. To aid in the construction of analytic models to completely represent propagation effect, it is necessary to perform definitive experiments under carefully controlled conditions. This is not always possible under actual at-sea conditions. It is necessary that a facility be developed at USL where key experiments can be performed which will go a long way to improving understanding of certain propagation phenomena. It is intended, also, that such a facility containing one or more carefully designed tanks, would support other investigative programs such as array configuration studies and system model studies. In the latter case, for instance, through direct linkage with USL's planned computer facility, various acoustic systems could be modeled and their performance could be evaluated.

SUPPORTED BY U.S. Dept. of Defense - Navy

12.0020, SYSTEM OPERATIONS AND ACOUSTIC PHYSICS

J.C. MUNSON, U.S. Navy, Research Laboratory, *Washington, District of Columbia*

Conduct a program which will lead to the specifications for undersea systems. The spectrum of work will include theoretical acoustics, systems concepts, validation of operational concepts, and systems analysis. Attention will be given to the Navy needs for systems in deep ocean and in shallow water areas. The work will be carried through to the development of experimental research systems which will be used both for research and to demonstrate conceptual and operational feasibility.

SUPPORTED BY U.S. Dept. of Defense - Navy

12.0021, HUDSON LABORATORIES SHIP SUPPORT

UNKNOWN, U.S. Navy, Military Sea Transp. Service, *Washington, District of Columbia* 20390

The emphasis on underwater sound propagation has necessitated an accelerated oceanographic research program. This effort together with the increasing use of larger and heavier research tools towed at greater depths has generated the requirements for an improved sea going research platform. At the request of ONR, the reserve fleet ship, USS SAN CARLOS was converted to meet these requirements and was recommissioned the USNS JOSIAH W. GIBBS (T-AGOR 1). It has been substantially modified in a progressive manner to continue to meet the ever changing requirements of the Hudson Laboratories at-sea phases.

MSTS will provide the services of USNS JOSIAH W. GIBBS (T-AGOR 1) to support the sea going phases of the research program of HUDSON LABORATORIES. MSTS will operate the GIBBS throughout FY 69. The ship will be under the operational control of MSTS and under the technical control of ONR. Detailed procedures are described in the joint memorandum of agreement between the Chief of Naval Research and Commander, Military Sea Transportation Service. The technical control will be transferred on 1 October 1968 to the Naval Research Laboratory under a new memorandum of agreement.

SUPPORTED BY U.S. Dept. of Defense - Navy

12.0022, SUPPORT OF THE COMMITTEE ON OCEANOGRAPHY OF THE NATIONAL ACADEMY OF SCIENCES

H.E. VANNESS, U.S. Navy, Office of Naval Research, *Washington, District of Columbia*

The Committee on Oceanography serves as advisor to the Federal Government on general as well as specific goals and problems associated with further development of national oceanographic programs. The Committee is sponsored jointly by the Office of Naval Research, the National Science Foundation, the Atomic Energy Commission, the Bureau of Commercial Fisheries, and the Environmental Science Service Administration.

The major accomplishment of the Committee on Oceanography during the past year was the completion of an extensive report, Oceanography 1966 - Achievements and Opportunities (NAS-NRC Publication 1492). The report contains a review of advances in oceanography during the past several years; a detailed analysis of the Committee's earlier report, Oceanography 1960 to 1970, that updates the Committee's previous recommendations and introduces some new topics; and a discussion of the problems of management, planning, and organization of the National Oceanographic Program.

During the year ahead, the Committee expects to focus its attention on several basic issues in ocean science. These will fall into two major categories: major scientific oceanographic problems and management problems affecting this nation's ability to conduct oceanographic research.

SUPPORTED BY U.S. National Science Foundation

12.0023, OPERATION OF THE R/V HERO AND PALMER STATION SUPPORT LABORATORY

S.T. CRAPO, Marine Acoustical Serv. Inc. , *Miami, Florida* 33135

This contract provides for the operation of the new 125 Ft. Antarctic Research Ship Hero and associated shore scientific laboratories in Antarctica. In addition to the actual operation of the ship, the contractor will be responsible for the management and support services necessary to enable scientific investigators and associated personnel to perform research aboard the Hero and at the biological laboratory located at Palmer Station, Antarctica.

SUPPORTED BY U.S. National Science Foundation

12.0024, SUPPORT OF RESEARCH VESSELS JOHN ELLIOTT PILLSBURY, GERDA, TURSIOPS

F.G. SMITH, Univ. of Miami, Graduate School, *Miami - Coral Gables, Florida* 33124

A. Geology and Geophysics: The oceanographic work in geology and geophysics at the Institute of Marine Sciences, University of Miami, covers a wide scope, including sedimentary petrology, mineralogy, micro-paleontology, paleotemperature determinations, absolute dating of sediments, and sedimentary ecology, as well as seismic reflection and gravity investigations. There were 18 professional geologists, geochemists, and geophysicists associated with the Institute involved in various aspects of the research. In addition, approximately 12 graduate students participated in the programs. B. Biological Oceanography: The biological program at the Institute of Marine Sciences encompassed investigations on the planktonic, nectonic and benthonic forms of coastal waters, the continental shelf and the deep ocean basins. Individual research efforts were directed toward understanding the systematics and distribution of fishes, crustaceans, echinoderms and cephalopods. Also studies on zooplankton and phytoplankton ecology, larval development, and marine bacteria and fungi were conducted. Approximately 20 scientists were associated with various phases of the work, and 28 graduate students also participated.

SUPPORTED BY U.S. National Science Foundation

12.0025, CURATING OF BLAKE PLATEAU CORES

F.G. SMITH, Univ. of Miami, Institute of Marine Science, *Miami — Coral Gables, Florida* 33124

This project will support a service function performed by the Insitute of Marine Science, University of Miami, on behalf of all member institutions of the Ocean Sediment Coring Program and other appropriately qualified scientists. The work will consist of curatorial care and distribution of core samples. The University of Miami will provide storage space for the cores and office and laboratory space for visiting scientists who come to the Institute to study the cores.

SUPPORTED BY U.S. National Science Foundation

12.0026, SUPPORT OF UNIVERSITY OF GEORGIA MARINE INSTITUTE RESEARCH VESSEL OPERATION

V.J. HENRY, Univ. of Georgia, Graduate School, *Sapelo Island, Georgia* 31327

This grant provides support of the R/V Kit Jones, a 65 foot diesel trawler outfitted with appropriate research equipment. The area of operation includes the estuaries, shelf and upper continental slope of coastal Georgia and southeastern United States. Cruises of several days duration can conveniently be made by 4 to 6 scientists and larger groups can be accomodated for one day. Shipboard equipment includes Decca radar, dual Loran units, ship-to-shore and CB radios, automatic pilot, recording fathometer, salinometer, transmissometer, winches, nets, dredges and corers.

The Kit Jones is used by the staff and visitors of the Marine Institute for research and instructional purposes. Research includes a large spectrum of biological and geological problems. Examples are pollution ecology, source and distribution of turbidity, and primary productivity of estuarine and coastal waters; and sediment distribution and structures, animal-sediment relationships, and topography and structure of the continental shelf and slope. A large number of training and collection cruises by Georgia and eastern universities and colleges are made each year and serve to introduce students from several disciplines and levels of instruction to the marine environment.

SUPPORTED BY U.S. National Science Foundation

12.0027, OPERATIONAL SUPPORT OF OCEANOGRAPHIC RESEARCH VESSELS

R.G. BADER, Univ. of Hawaii, Graduate School, *Honolulu, Hawaii* 96822

Support for approximately 60% of the operating cost for University of Hawaii's R/V TERITU and charter costs for 118 days of use of the R/V SITKIN will be provided for a one year period. This will amount to a total of 268 ship days. The requirement for the second vessel is due in part to the fact that several projects concerned with seismic refraction work involve the use of two vessels simultanelusly. Also TERITU is a small vessel (90 ft. l.o.a.) carrying a scientific party of 6 and therefore capable of being scheduled only for single project cruises.

Projects to be carried out involving use of NSF supported ship time include: studies of dissolved oxygen in sea water in relationship to water masses around Hawaii; studies of ocean turbulence; seismic refraction studies of crustal and upper mantle structure in the vicinity of the Murray Fracture Zone and over selected volcanic submarine ridges and seamount chains; a comprehensive geologic and geophysical study of the structural relationships between mid-Pacific oceanic ridges and fracture zones involving magnetic surveys, seismic reflection studies, precision echo-sounding surveys, gravimetric profiles, bottom sampling and photography; studies of crystalline mineral colloids in marine sediments; and analyses of tropical zooplankton.

SUPPORTED BY U.S. National Science Foundation

12.0028, MANAGEMENT OF THE ENIWETOK MARINE BIOLOGICAL LABORATORY

R.W. HIATT, Univ. of Hawaii, Graduate School, *Honolulu, Hawaii* 96822

This grant is for the management of the Eniwetok Marine Biological Laboratory, a facility available to male citizens engaged in marine biological research. A good laboratory, reasonably equipped, and with good logistic support is located on an atoll lagoon containing excellent coral reefs and some relatively undisturbed terrestrial environment. Inquiries for working space and feasibility of research intended at Eniwetok are to be sent to Dr. Robert W. Hiatt, Laboratory Manager, University of Hawaii, 2444 Dole St., Honolulu, Hawaii 96822. Travel to and from Eniwetok, subsistence at the site and laboratory facilities are provided at no cost to investigators.

SUPPORTED BY U.S. Atomic Energy Commission

12.0029, LOGISTIC SUPPORT, MAINTENANCE AND RENOVATION OF FACILITIES

C.E. WILDE, Mount Desert Island Biol. Lab, *Salsbury Cove, Maine*

The Mount Desert Island Biological Laboratory is an independent institution providing research facilities to qualified investigators whose programs in marine biology or local fauna and flora can be accommodated. Approximately 30 research groups are present each season (June 15 - Sept. 15) with investigators from about two dozen institutions located in 14 - 18 states. Summaries of the programs are published in the Bulletin of the Laboratory issued annyally. Applications for research space and housing facilities should be addressed to the Director.

SUPPORTED BY U.S. National Science Foundation

12.0030, LOGISTIC SUPPORT AND MAINTENANCE OF FACILITIES

C.E. WILDE, Mount Desert Island Biol. Lab, *Salsbury Cove, Maine*

The Mt. Desert Island Biological Laboratory is one of very few independent marine biological research stations in the United States. It was founded in 1898 at South Harpswell, Maine, incorporated in 1914, and has functioned as a seasonal field station at Salisbury Cove, Maine. The laboratory has operated uniquely by cooperative voluntary efforts of its investigators. At the present time the yearly paid employees are in full time maintenance men and part time assistant director. The officers serve without remuneration.

Located on Frenchmen Bay, there is immediate access to organisms of the cold Atlantic waters as well as to environments of rocky shores, fresh water lakes, bogs, meadows and spruce forests. Acadia National Park is close by. The individual research programs carried out at the Laboratory represent a broad spectrum of marine biological research. The advantages of the later summer breeding seasons of certain invertebrates, the greater availability of other organisms throughout the season and special ecological aspects of the location have led to emphasis on certain kinds of research: comparative physiology of fish (especially renal and respiratory physiology); various aspects of development using marine eggs; problems of ion transport, cell division, regeneration, botanical ecology, fine structure, organ biochemistry, hemodynamics and general comparative physiology.

SUPPORTED BY U.S. National Science Foundation

12.0031, STUDIES ON THE PHYSIOLOGY OF MARINE ORGANISMS USING RADIOISOTOPES

H.B. STEINBACH, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543 (AT(30-1)1343)

This contract is in partial support of a continuing service facility maintained to provide a wide variety of requirements--isotopes, chemicals, equipmemt, research space--for the radiobiological research of about seventy-five senior scientists each summer. Assigments of space for next summer will be made early in 1967.

SUPPORTED BY U.S. Atomic Energy Commission

12.0032, RESEARCH TRAINING LABORATORY

H.B. STEINBACH, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543

The Research Training Building to be supported under this grant will consist of 4 floors and a basement totalling 65,000 gross feet (44,200 Net). The new building has been carefully designed to ensure that each course will be operated as an integrated physical unit and that a close working relationship will be maintained between the staff and the students. The basic plan focuses on a central trainee area surrounded by individual staff research space and specialized purpose rooms.

The basic objective of the Marine Biological Laboratory has been the development of young scientists well-trained in the biological marine sciences. Almost from the beginning of MBL a series of advanced research-training courses in several substantive areas of marine biology have been conducted at the Laboratory. All of the buildings in which these courses are now given are antiquated wooden structures erected during the late 1890's. The need for a modern facility is urgent. The increased sophistication of research techniques in experimental biology require adequate space to conduct the courses. The core of the research-training program is vested in five formal summer courses: Invetebrate Zoology, Marine Botany, Physiology, Experimental Embryology, and Marine Ecology. With a senior staff of 40 and 12 staff assistants, the new building will house more than 240 individuals in the research- training programs. In addition to the summer programs, the new laboratory will house the year-round research project: the Systematics- Ecology Program. This group has a senior staff of 25 investigators who will occupy all of the first floor and a portion of the basement. Other expanded activities are planned for spring and fall courses when the new laboratory is completed. 52

SUPPORTED BY U.S. National Science Foundation

12.0033, PROVIDE RESEARCH FACILITIES AND SERVICES

UNKNOWN, Marine Biolog. Laboratory, *Woods Hole, Massachusetts* 02543 (PH-43-67-1129)

Independently and not as an agent of the Government, the Contractor shall furnish approximately 1,422 square feet of space and supporting services to three groups of Government investigators (totaling approximately 28 individuals) for use in conducting research studies on various forms of living marine life. The fixed rate for space, plus supporting services hereafter designated as a 'Research Fee' shall be charged in accordance with the following schedule: (1) NINDB Biophysics Branch has rooms 121, 122, 123, 113A, each of which has a basic occupancy of up to two persons each; research fee is $1,560. (2) NINDB Optholmology Branch has room L315 (same basic occupancy); research fee is $480. (3) NIMH has room 216 (same basic occupancy); research fee is $2,160. (4) NIAMD has rooms L321-W221 (same basic occupancy); research fee is $840. (5) Twelve extra persons (NINDB Biophysics, 3; NINDB Optholmology, 1; NIMH, 4; NIAMD, 4); research fee is $1,440. Total research fee is $6,480.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

12.0034, SUPPORT OF TWO RESEARCH VESSELS

D.C. CHANDLER, Univ. of Michigan, Graduate School, *Ann Arbor, Michigan*

This project provides full support for the operation of two research vessels currently in use on the Great Lakes for program activities of the Great Lakes Research Division of University of Michigan's Institute of Science and Technology. Will provide funds for operating the 114-ft. INLAND SEAS and the 50-ft. MYSIS. This project will be joint funded.

Research activities involving use of these vessels are concerned with specific problems in the Great Lakes and their tributaries, with emphasis on the physical, chemical and biological processes and phenomena of the waters within the lake basins and on the interactions between these waters and their atmospheric and geologic boundaries. In addition to being used to conduct the University of Michigan's research efforts, these vessels are made available to other midwestern universities for research and educational purposes.

SUPPORTED BY U.S. National Science Foundation

12.0035, EXPERIMENTAL COMMERCIAL OPERATION OF SAVANNAH

UNKNOWN, First Atomic Ship Transp. Inc. , *Hoboken, New Jersey*

Purpose: To operate the SAVANNAH on an experimental commercial basis, and establish operational data as to the reliability, economics and safety of nuclear ships for use in future planning for advanced nuclear ship designs.

Description: The SAVANNAH has been operating in regularly scheduled commercial cargo liner service efficiently, reliably and on schedule for three years with no serious mechanical or operational problem. All safety requirements of the Atomic Energy Commission and the Coast Guard have been met. Records and analyses of operational cost factors have been prepared to provide basis for improved future designs.

During the past year, deck Officers were licensed as Reactor Operators for the first time, annual outage time was reduced from 30 to 12 days, and initial visits were made to the following countries: Yugoslavia, Tunisia, Greece, Israel, Cyprus, Okinawa, Lebanon, Korea, Phillipines, and Taiwan. The original reactor core is still intact; the SAVANNAH is due for a shuffle refueling outage of about 2-3 months beginning in August, 1968. 0113

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

12.0036, RESEARCH VESSEL U.S.N.S ELTANIN

W. SMOLEN, Alpine Geophysical Associates, *Norwood, New Jersey*

This contract provides for the field party technical support on board the Antarctic research ship Eltanin, for the procurement of specialized scientific and oceanographic equipment used in the research project, and for the cargo handling and logistic processing related to the Eltanin scientific activities. This amendment provides for additional equipment, supplies, and personnel changes necessary for carrying out these functions.

SUPPORTED BY U.S. National Science Foundation

12. FACILITIES

12.0037, SUPPORT OF RESEARCH VESSEL AT LAMONT GEOLOGICAL OBSERVATORY

J.L. WORZEL, Columbia University, Graduate School, *Palisades, New York* 10964

This project supports approximately half the operating costs of two research vessels, VEMA and CONRAD, operated by Lamont Geological Observatory of Columbia University. This amounts to about $605,400 of which 15% or $90,800 is related to biological research and the remaining 85% or $514,600 for physical oceanogrpahy.

The main objective of oceanographic research to be carried out on R/V VEMA and CONRAD in the next year continues to be the assessment of the sedimentary distribution and the identification of three layers which are generally found in the oceans of the world. Another objective is the study of the magnetic seismic refraction program is presently underway with the Japanese and a similar one planned with the Australians. These cooperative programs have the advantage of providing a second ship for two-ship operations without additional ship operating costs for Lamont. In conjunction with these major objectives, an integrated program of geophysical-geological investigations is planned for the tracks en route and return from the main research areas.

SUPPORTED BY U.S. National Science Foundation

12.0038, TRANSPORTATION EXPENSES FOR PARTICIPATION IN USC&GSS OCEANOGRAPHER GLOBAL EXPEDITION

P.K. WEYL, State University of New York, Graduate School, *Stony Brook, New York* 11790

This grant is to cover travel expenses and shipment of equipment for personnel to join the USC & GSS OCEANOGRAPHER and carry out research in three projects to develop a research program in oceanography.

SUPPORTED BY U.S. National Science Foundation

12.0039, SUPPORT OF THE R/V EASTWARD

C.G. BOOKHOUT, Duke University, Graduate School, *Beaufort, North Carolina* 28516

This grant provides support for the operation of the R/V EASTWARD for approximately 11 months. The R/V EASTWARD is an 118-ft. steel hulled research vessel built with assistance from NSF for the purpose of furnishing an available facility for training, research and participation in international cooperative programs of biological oceanography. The program carried out by this research vessel includes both research and training projects.

Each year a National Project and Program Review committee reviews this program and upon their recommendation shiptime is made available. This year the Committee approved a total of 279 days of shiptime. By combining related research programs this was reduced to 237 days. Twenty-three institutions wil participate in this Cooperative Program during 1968-69. Included in a 90 day cruise to the Caribbean in addition to her continuing program of research along the continental shelf of Cape Hatteras.

SUPPORTED BY U.S. National Science Foundation

12.0040, COOPERATIVE RESEARCH AND RESEARCH TRAINING PROGRAM IN BIOLOGICAL OCEANOGRAPHY

R.J. MENZIES, Duke University, Marine Laboratory, *Beaufort, North Carolina* 28516

This grant supported the operation of the Research Vessel EASTWARD and the cooperative research and research training program in biological oceanography. Participation in the program is open to all qualified individuals on a competitive basis.

SUPPORTED BY U.S. National Science Foundation

12.0041, RESEARCH VESSEL OPERATIONS

W.V. BURT, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

These vessels will be used to conduct a wide spectrum of oceanographic research in the northwestern coastal waters and in the Northeast Pacific. Most cruises are multidisciplinary. Graduate students presently numbering 102 participate extensively in shipboard activities. Visiting investigators are also accommodated whenever possible.

SUPPORTED BY U.S. National Science Foundation

12.0042, OPERATION AND MAINTENANCE OF THE OREGON STATE UNIVERSITY SEAFOODS LABORATORY

D.L. CRAWFORD, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

Objective: To provide for the operation and maintenance of the Oregon State University Seafoods Laboratory at Astoria, Oregon, which operates as an integral part of the Department of Food Science and Technology.

Description of Work: This laboratory provides a center at which applied basic research in the field of marine food science and technology can be conducted in close cooperation with and for the development of the fishing industry of Oregon. Its close proximity to the major fishing industry of Oregon facilitates and speeds the dissemination of knowledge obtained through research at the center and elsewhere necessary to bring about needed technological development.

SUPPORTED BY Oregon State Government

12.0043, THE INSTITUTE FOR THE DEVELOPMENT OF RIVERINE AND ESTUARINE SYSTEMS (IDRES)

J.R. FELDMEIER, Franklin Institute, *Philadelphia, Pennsylvania*

The Franklin Institute will establish, in cooperation with the Academy of Natural Sciences of the State of Pennsylvania, Lehigh University and Temple University, The Institute for the Development of Riverine and Estuarine Systems (IDRES). These institutions will conduct basic research programs focused on the long term objectives of better utilization resources of the Delaware riverine-estuarine complex including effects of thermal pollution in the Delaware River, effects of thermal effluent discharge, the mechanics and thermodynamics of the distribution and mixing of thermal effluence, and the development of a conceptual model of sedimentation of the Delaware riverine estuarine complex. In addition, an information center to serve the principal investigators conducting this research and as a focal point of coordination with other Federal and private information centers related to estuarine problems will be established by the Franklin Institute. Study and design of an industrial wasteline for the Delaware estuary with a view toward study of an alternative method to that now available for the disposal of waste will be begun.

SUPPORTED BY U.S. National Science Foundation

12.0044, LABORATORY OF NEUROBIOLOGY

J. DELCASTILLO, Univ. of Puerto Rico, School of Medicine, *San Juan - Rio Piedras, Puerto Rico* 00931

The purpose of this application is to set up a laboratory devoted to the investigation of neurobiological problems primarily through the use of invertebrate organisms, thus taking advantage of the rich fauna which inhabits the littoral waters of Puerto Rico. The University of Puerto Rico Medical School could make a significant contribution to biomedical research by introducing scientists to new organisms, cells and preparations which, due to the restricted geographical distribution of existing marine biological laboratories with adequate facilities, have so far been unavailable for biophysical and biochemical research. It could therefore, fill a national and even an international need. Initial work will probably deal with problems related to the conduction and spread of excitation within coral colonies; the chemistry and actions of neurotoxins and pharmacologically active compounds produced by tropical fishes and invertebrates; physiology and molluscan nerve cells; excitation-contraction and excitation-relaxation mechanisms in invertebrate muscles; induction, nature and mechanism of activation of chemoreceptors in nerve and muscle cells and the electrophysiology of neurosecretory cells. Actual results cannot be anticipated easily, since the immediate task of the laboratory will be an exploratory one. The laboratory envisaged in this application will be open to graduate students and visiting scientists. It may, therefore, play an important role both in the development of the graduate divisions of the U.P.R. and the establishment of closer academic ties between the countries of the two large American Continents.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel.- P.H.S.

12.0045, OPERATION OF R/V TRIDENT

J.A. KNAUSS, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

Support for approximately half the cost of operating University of Rhode Island's research vessel TRIDENT will be provided for a one year period. R/V TRIDENT is a converted Army, FS freighter used to carry out a broad spectrum of scientific cruises in the Atlantic and Caribbean. Cruise participants include URI faculty and graduate students and guest investigators from other institutions. Cruises planned for the coming year will encompass the following areas of study: collection and analysis of rock samples from the Mid-Atlantic Ridge south of Iceland to test the seafloor spreading hypotheses; temporal aspects of vertical distribution of pelagic organisms; ecology and nutrient requirement of phytoplankton in the Gulf of Panama; bioacoustic investigation of cetacean and fish sounds; sub-bottom investigation of the post cretaceous drainage pattern in the approaches to Rhode Island and Block Island Sounds.

Total direct costs for the year beginning 9/1/67 for operation of R/V TRIDENT are $501,935. This project will fund $251,000 of which approximately 2/5 or $100,400 is for biologically oriented shipboard work and 3/5 or 150,600 for shiptime related to physical, chemical and geological oceanographic research.

SUPPORTED BY U.S. National Science Foundation

12.0046, OPERATION OF R/V ALAMINOS

R.A. GEYER, Texas A & M University System, Graduate School, *College Station, Texas* 77843

This project provides a continuation of partial support of R/V ALAMINOS, which is operated by the Department of Oceanography of Texas A & M University. Total costs for operating this vessel for the coming year (1 October 1968 to 30 September 1969) are estimated to be $461,400. The Foundation will contribute $203,900 toward this total and the remaining funds will be derived from other sources. This project will be joint funded in the following manner: DES, $148,500; BMS, $55,400.

Research projects requiring use of the ALAMINOS represent a broad spectrum of oceanographic effort, most of which is carried out in the Gulf of Mexico and the Caribbean. The coming year's schedule will also include work in the Eastern Equatorial Pacific in cooperation with another oceanographic institution. Examples of studies to be carried out in the coming year include the following: current measurements in the Gulf Loop and Yucatan Currents; characterization and distribution in space and time of particulate and soluble, inorganic and organic carbon species in sea water; geological and geophysical studies of sediment structures in various physiographic provinces of the Gulf and Caribbean; benthic collections and photographic observations in the western Gulf.

SUPPORTED BY U.S. National Science Foundation

12.0047, OCEANOGRAPHIC VESSEL OPERATIONS

F. A. RICHARDS, Univ. of Washington, Graduate School, *Seattle, Washington* 98122

This project provides approximately 41% of the total funds required for the coming year in support of ship operations at the University of Washington. The Oceanography Department operates the R/V THOMPSON, HOH and ONAR and supplements them with a charter vessel to be used for approximately 69 days. Total fleet funding also includes $1,000 for charter of a small aircraft for making a variety of water surface observations from the air. Total costs for ship operations and charter purposes will be $954,694, of which $558,687 is available from other sources. Foundation support will total $396,000, of which $230,900 is for shiptime for physical, geological and chemical oceanographic studies and $165,100 for biological oceanographic studies.

The oceanography program of the University of Washington is concerned primarily with the Northeast Pacific Ocean, Puget Sound and its approaches and the Arctic Sea; and secondarily with the eastern tropical Pacific Ocean and the Caribbean Sea. Current programs emphasize studies in: geology and geophysics dealing with analyses of sediments in the inshore regions and in the North Pacific Ocean; chemistry and geochemistry particularly concerned with nutrients and dissolved gases in the sea; physical oceanography concerned with the dynamics of discrete water parcels in the inshore regions and physical parameters of Arctic waters; biological oceanography dealing with plankton productivity studies in Puget Sound, off the Washington-Oregon coast, and in the Arctic.

SUPPORTED BY U.S. National Science Foundation

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WOODS HOLE ENVIRONMENTAL STUDIES OCEANIC ACOUSTICS ...Acoustical, Atlantic Ocean-north, Benthonic-bottom, Data Analysis - General, Reverberation, ...**1.0057**

MICROACOUSTICS ...Acoustical, Reflection, Sound Gear, Water Tunnels Tables, ...**1.0043**

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EXPERIMENTS IN AIR-SEA INTERACTION INVOLVING SURFACE PRESSURE MEASUREMENTS ...Pressure-density, Wind-other, Wind-water Interaction, ...**3.0017**

Convection

RESEARCH ON DYNAMICS OF LOW LATITUDE CIRCULATIONS ...Heat Exchange, Meteorological Studies, Patterns, Shear, Tropical Cyclones, ...**3.0050**

ATMOSPHERIC CONDITIONS ASSOCIATED WITH CUMULUS CONVECTION ...Cumulus, Meteorologic Model Studies, Shear, Tropical Cyclones, Velocity, ...**3.0045**

MESO AND CONVECTIVE SCALE SYSTEMS IN THE MARITIME TROPICAL ATMOSPHERE ...Air Motion-general, Heat Budget, Islands, Meteorologic Model Studies, Tropic, ...**3.0062**

RESEARCH ON TURBULENT CONVECTION ...Forced Convection, Laboratory Analysis, Stratified, Turbulence, Turbulent, ...**2.0058**

Diffusion

HYDROSPHERE-ATMOSPHERE RADIOCHEMICAL MEASUREMENTS ...Carbon, Nuclear Explosions - Fallout, Particle-gas Transfer, Tracers, Velocity, ...**3.0043**

STRUCTURE OF TURBULENCE ...Boundary Layer Studies, Turbulence, ...**8.0075**

ARGONNE MICROMETEOROLOGICAL MODELING FACILITY PROPOSAL ...Meteorologic Model Studies, Micrometeorology, Public Health, Turbulence, Wind Tunnels, ...**4.0071**

ANALYSIS OF THE MARINE LAYER - A MESO METEOROLOGICAL STUDY ...Air-sea Boundary-general, California, Heat Exchange, Orographic Effects, Turbulence, ...**3.0001**

Patterns

CLOUD PATTERNS RELATED TO SELECTED CIRCULATION SYSTEMS IN EASTERN PACIFIC ...Meteorological Studies, Photographic, Satellites, ...**4.0138**

RESEARCH ON DYNAMICS OF LOW LATITUDE CIRCULATIONS ...Convection, Heat Exchange, Meteorological Studies, Shear, Tropical Cyclones, ...**3.0050**

TROPOSHERE METEOROLOGY IN THE TROPICAL ATLANTIC AREA ...Anticyclones-cyclones, Atlantic Ocean-general, Clouds-precipitation, Meteorological Studies, Tropic, ...**3.0049**

APPLICATION OF METEOROLOGICAL SATELLITE SENSING TO GENERAL CIRCULATION MODELS ...Infrared Radiation, Meteorologic Model Studies, Particle-gas Transfer, Satellites, Thermodynamics, Weather Forecasting, ...**4.0137**

EQUATORIAL CIRCULATIONS IN THE STRATOSPHERE ...Atmospheric Divisions, Mass Transport, Ocean-lakes, Tropic, ...**3.0066**

WEATHER PROGRAM - STATION T-3 ...Arctic Ocean, Drift Stations, Energy Exchange Processes, Heat Budget, Physical Climatology, Weather Forecasting, ...**3.0060**

LARGE-SCALE INERTIAL OCEAN-ATMOSPHERE RELATIONSHIPS ...Air-sea Boundary-general, Greenland Sea, Jet

Streams, Sea Ice, Sea of Okhotsk, Weather Forecasting, ...3.0024

PACIFIC OCEAN INFLUENCE UPON CALIFORNIA RAINFALL ...California, Forecasting, Pacific Ocean-general, Rain-other, Temperature, ...3.0057

THREE-DIMENSIONAL GLOBAL CLIMATOLOGY ...Air Motion-general, Applied Climatology, General Movement, Spectral Analysis, Tables, Compilations, Catalogs, ...3.0067

RELATION OF SATELLITE DATA TO LARGE SCALE ATMOSPHERIC CIRCULATION AND ENERGETICS ...Anticyclones-cyclones, General Movement, Radiation-general, Satellites, Weather Charts-maps, ...4.0143

MESOSCALE WIND SYSTEMS AROUND THE GREAT LAKES ...General Synoptic Observations, Lake Michigan, Land-sea Breezes, Meteorologic Model Studies, Pollution Behavior-general, ...3.0064

Turbulence

DYNAMICS OF INTERNAL WAVES AND TURBULENCE IN THE THERMOCLINE ...Density, Salinity, Turbulent Flow, ...2.0093

DEVELOPMENT OF PHYSICAL-NUMERICAL MODELS FOR STUDIES OF THE ATMOSPHERE-OCEAN PLANETARY BOUNDARY LAYER ...Advection, Mixing, Simulation Theory, Thermal, Wind-water Interaction, ...3.0010

RESEARCH ON TURBULENT CONVECTION ...Convection, Forced Convection, Laboratory Analysis, Stratified, Turbulent, ...2.0058

ENERGY TRANSFER NEAR THE EARTHS SURFACE ...Air Motion Instruments, Buoys, Heat and Radiation Transfer, Thermodynamics, ...3.0044

INTERACTIONS BETWEEN TURBULENCE, CLOUDS, SEA TEMPERATURE ...Data Analysis - General, Indian Ocean-general, Line Islands, Patterns, Temperature, ...3.0025

MARINE ATMOSPHERIC RESEARCH FACILITY ...Air-sea Boundary-general, Instrumental Services, Meteorological Studies, Platforms, Telemetry-other, Weather Modification-general, ...8.0322

WAVE GENERATION BY THE TURBULENT WIND FIELD OVER THE SEA ...Platforms, Pressure-density, Velocity, Waves, Wind-water Interaction, ...3.0008

TURBULENT PROCESSES AT AIR-SEA AND BOTTOM BOUNDARIES OF THE OCEAN ...Currents-bottom, Thermal, Waves, Wind-water Interaction, ...3.0033

TURBULENCE OVER WAVES ...Forecasting-prediction, Heat and Radiation Transfer, Heat Exchange, Meteorological Studies, Thermal, Waves, ...3.0027

HETERODYNE MEASUREMENTS OF ATMOSPHERIC PHASE TURBULENCE AT 6328A ...Heterodyne System, Other-design-and-construction, Phase, Transmission, ...8.0190

STRUCTURE OF TURBULENCE ...Boundary Layer Studies, Diffusion, ...8.0075

ATMOSPHERIC TURBULENCE FIELD STUDIES ...Air Motion Instruments, Air-sea Boundary-general, Boundary Layer Studies, Heat Exchange, Velocity, ...3.0020

ARGONNE MICROMETEOROLOGICAL MODELING FACILITY PROPOSAL ...Diffusion, Meteorologic Model Studies, Micrometeorology, Public Health, Wind Tunnels, ...4.0071

ANALYSIS OF THE MARINE LAYER - A MESO METEOROLOGICAL STUDY ...Air-sea Boundary-general, California, Diffusion, Heat Exchange, Orographic Effects, ...3.0001

Vorticity

TROPICAL STORM INVESTIGATIONS IN THE ATLANTIC, CARIBBEAN, AND GULF OF MEXICO ...Meteorological Studies, Satellites, Tropic, Tropical Cyclones, Waves, ...3.0048

Wind

Direction

LAKE EFFECT SNOWSTROM STUDY ...Great Lakes-general, Modification, Nucleation Physics, Orographic Effects, Patterns, ...3.0052

Land-sea Breezes

SEA BREEZE INVESTIGATION ...Data Analysis - General, Energy-general, Gulf of Mexico, Heat and Radiation Transfer, Texas, ...3.0040

MESO WIND PATTERNS IN THE CENTRAL CALIFORNIA VALLEY ...Atmospheric Pollution-general, California, Drift (pesticide), Herbicides -non-specific, Wind Erosion, ...3.0056

MESOSCALE WIND SYSTEMS AROUND THE GREAT LAKES ...General Synoptic Observations, Lake Michigan, Meteorologic Model Studies, Patterns, Pollution Behavior-general, ...3.0064

Ocean-lakes

EQUATORIAL CIRCULATIONS IN THE STRATOSPHERE ...Atmospheric Divisions, Mass Transport, Patterns, Tropic, ...3.0066

STUDY ASSOCIATION BETWEEN TRADE WIND SYSTEM AND NORTH PACIFIC OCENAOGRAPHIC CLIMATE ...Hawaii, Meteorological Studies, Temperature, Waves, Wind-water Interaction, ...3.0019

SURVIVAL CRAFT DRIFT AND LEEWAY ...Air Motion Instruments, Buoys, Currents-ocean, Equipment, Operational Aspect, Tables, Compilations, Catalogs, ...6.0129

BARBADOS OCEANOGRAPHIC AND METEOROLOGICAL EXPERIMENT ...British West Indies, Depth, Salinity, Temperature, Wind-water Interaction, ...3.0015

Orographic Effects

LAKE EFFECT SNOWSTROM STUDY ...Direction, Great Lakes-general, Modification, Nucleation Physics, Patterns, ...3.0052

ANALYSIS OF THE MARINE LAYER - A MESO METEOROLOGICAL STUDY ...Air-sea Boundary-general, California, Diffusion, Heat Exchange, Turbulence, ...3.0001

Profiles

MARINE METEOROLOGY UNTENDED STATION DEVELOPMENT ...Air Motion Instruments, Automatic Stations, Buoys, Meteorological Studies, Platforms, ...8.0285

AIR-SEA INTERACTION PROCESS ...Boundary Layer Studies, Buoys, Circulation-general, Lakes, Wind-water Interaction, ...3.0028

AIR/SEA INTERACTION STUDY ...Convection, Mixing, Thermal, Thermocline, Waves, ...2.0114

OCEAN WAVES ...Model Studies, Temperature, Waves, Waves-internal, Wind-water Interaction, ...3.0004

DYNAMICS OF AIR-SEA INTERACTION ...Heat and Radiation Transfer, Meteorological Studies, Particle-gas Transfer, Surface Environments, Wind-water Interaction, ...3.0022

WAVE MEASUREMENT IN THE OPEN OCEAN ...Buoys, Data Acquisition, Oceanic - Pelagic, Water Motion Recorders, Waves, ...2.0109

WAVE GENERATION ...British West Indies, Shear, Towers, Waves, Wind-water Interaction, ...2.0103

Shear

RESEARCH ON DYNAMICS OF LOW LATITUDE CIRCULATIONS ...Convection, Heat Exchange, Meteorological Studies, Patterns, Tropical Cyclones, ...3.0050

ATMOSPHERIC CONDITIONS ASSOCIATED WITH CUMULUS CONVECTION ...Convection, Cumulus, Meteorologic Model Studies, Tropical Cyclones, Velocity, ...3.0045

ATMOSPHERIC PROCESSES IN THE TROPICS ...Data Reduction and Analysis, Patterns, Statistics-general, Tropic, Tropical Cyclones, ...3.0059

(U) OCEAN CIRCULATION MODELS ...Circulation-general, Currents-ocean, Model Studies, Waves, Wind-water Interaction, ...2.0024

WAVE GENERATION ...British West Indies, Profiles, Towers, Waves, Wind-water Interaction, ...2.0103

GREAT LAKES RESEARCH - LAKE WAVES ...Great Lakes-general, Water Motion Recorders, Waves, Wind-water Interaction, ...2.0118

Velocity

ATMOSPHERIC CONDITIONS ASSOCIATED WITH CUMULUS CONVECTION ...Convection, Cumulus, Meteorologic Model Studies, Shear, Tropical Cyclones, ...3.0045

UTILIZATION OF SYNCHRONOUS SATELLITE DATA ...Height - Ceiling, Patterns, Satellites, Technique Development, Weather Forecasting, ...4.0173

HYDROSPHERE-ATMOSPHERE RADIOCHEMICAL MEASUREMENTS ...Carbon, Diffusion, Nuclear Explosions - Fallout, Particle-gas Transfer, Tracers, ...3.0043

WHITECAPPING ...Meteorological Studies, Particle-gas Transfer, Temperature, Waves, Wind-water Interaction, ...2.0120

OCEAN WIND WAVE GENERATION AND DISSIPATION ...Buoys, General Synoptic Observations, North Sea, Waves, Wind-water Interaction, ...2.0105

WAVE GENERATION BY THE TURBULENT WIND FIELD OVER THE SEA ...Platforms, Pressure-density, Turbulence, Waves, Windiwater Interaction, ...3.0008

ATMOSPHERIC TURBULENCE FIELD STUDIES ...Air Motion Instruments, Air-sea Boundary-general, Boundary Layer Studies, Heat Exchange, Turbulence, ...3.0020

MEASUREMENT AND PREDICTIVE STATISTICS OF REVERBERATION ...Acoustical, Geomorphology-topography, Reverberation, Scattering, Surface Environments, Textures-structures, ...1.0007

Wind-general

PREDICTION OF EXTREME ENVIRONMENTAL FACTORS ...Forecasting-prediction, Meteorological Extremes, Statistics-general, Technique Development, Waves, ...4.0048

THE PROPAGATION OF ACOUSTIC WAVES IN THE STRATIFID ATMOSPHERES ...Acoustics, Temperature, Transmission, Waves, ...1.0059

EASTERN BOUNDARY CURRENTS ...Mixing, Ocean Currents-other, Pressure-density, Wind-water Interaction, ...2.0026

THE NET EFFECT OF WIND ON RECREATIONAL TIDAL STREAMS IN FLORIDA ...Air-sea Boundary-other, Estuaries, Florida, Tides, Water Level Fluctuation, ...2.0082

OBJECTIVE WEATHER ANALYSIS ...Research - Development, Technique Development, Tropic, Weather Forecasting, ...4.0042

Wind-other

EXPERIMENTS IN AIR-SEA INTERACTION INVOLVING SURFACE PRESSURE MEASUREMENTS ...Air Motion-other, Pressure-density, Wind-water Interaction, ...3.0017

Air Motion Instruments

MARINE METEOROLOGY UNTENDED STATION DEVELOPMENT ...Automatic Stations, Buoys, Meteorological Studies, Platforms, Profiles, ...8.0285

ENERGY TRANSFER NEAR THE EARTHS SURFACE ...Buoys, Heat and Radiation Transfer, Thermodynamics, Turbulence, ...3.0044

ATMOSPHERIC TURBULENCE FIELD STUDIES ...Air-sea Boundary-general, Boundary Layer Studies, Heat Exchange, Turbulence, Velocity, ...3.0020

SURVIVAL CRAFT DRIFT AND LEEWAY ...Buoys, Currents-ocean, Equipment, Ocean-lakes, Operational Aspect, Tables, Compilations, Catalogs, ...6.0129

Tracers

TRITIUM IN HURRICANES ...Aircraft, Heat and Radiation Transfer, Heat Exchange, Particle-gas Transfer, Tritium, Tropical Cyclones, ...3.0047

HYDROSPHERE-ATMOSPHERE RADIOCHEMICAL MEASUREMENTS ...Carbon, Diffusion, Nuclear Explosions - Fallout, Particle-gas Transfer, Velocity, ...3.0043

Wind Tunnels

ARGONNE MICROMETEOROLOGICAL MODELING FACILITY PROPOSAL ...Diffusion, Meteorologic Model Studies, Micrometeorology, Public Health, Turbulence, ...4.0071

Air Pollution-chemistry

COMPOSITION OF LEAD HALIDE POLLUTION AEROSOLS ...Activation Analysis, Aerosols, Air Pollution Sampling, Condensation, Oxidation-general, ...6.0156

Air Temperature Instruments

NUMERICAL CODE CONVERTER ...Humidity Instruments, ...8.0078

Air-earth Interface

Boundary Layer Studies

AIR-SEA INTERACTION PROCESS ...Buoys, Circulation-general, Lakes, Profiles, Wind-water Interaction, ...3.0028

LINE ISLANDS EXPERIMENT ...General Synoptic Observations, Line Islands, Physical Climatology, Satellites, Wind-water Interaction, ...3.0063

ATMOSPHERIC-OCEANIC-GLACIOLOGIC INTERACTIONS IN THE ANTARCTIC ...Antarctica, Heat Budget, Heat Exchange, ...3.0009

STRUCTURE OF TURBULENCE ...Diffusion, Turbulence, ...8.0075

ATMOSPHERIC TURBULENCE FIELD STUDIES ...Air Motion Instruments, Air-sea Boundary-general, Heat Exchange, Turbulence, Velocity, ...3.0020

Air-sea Boundary Studies

Air-sea Boundary-general

DEVELOPMENT EXPERIMENTAL SYSTEM FOR AIR SEA INTERACTIONS ...British West Indies, Buoys, Meteorological Studies, ...4.0008

COMMITTEE ON OCEANOGRAPHY ...Committee-support, Marine Environments-general, Oceanography-general, Radioactivity-general, ...11.0016

AIR-SEA INTERACTION ...Currents-ocean, Gulf of Mexico, Thermal, Tropical Cyclones, Weather Forecasting, ...3.0042

OCEAN-ATMOSPHERE STUDIES WITH STABLE ISOTOPES AND DISSOLVED GASES ...Equilibrium - Chemical, Gases, Mixing, Oceanic Fronts, Particle-gas Transfer, Tracers, ...3.0005

LARGE-SCALE INERTIAL OCEAN-ATMOSPHERE RELATIONSHIPS ...Greenland Sea, Jet Streams, Patterns, Sea Ice, Sea of Okhotsk, Weather Forecasting, ...3.0024

EXCHANGE METEOROLOGIST WITH JAPANESE ANTARCTIC RESEARCH EXPEDITION ...Antarctic Ocean, General Synoptic Observations, Mixing, Radiosonde, Sea Ice, ...3.0013

SUPPORT OF TWO RESEARCH VESSELS ...General Sea Water Chemistry, Great Lakes-general, Marine Biology, Ships and Cruises, Water Properties-general, ...12.0034

TRANSPORT PROCESSES ACROSS AN AIR-WATER INTERFACE ...Model Studies, Statistics-general, Wind-water Interaction, ...3.0003

MARINE ATMOSPHERIC RESEARCH FACILITY ...Instrumental Services, Meteorological Studies, Platforms, Telemetry-other, Turbulence, Weather Modification-general, ...8.0322

THE OCCURRENCE AND EFFECTS OF PLANKTON IN THE SEA ...Marine Biology, Plankton (non-specific), ...5.0781

USE OF ON-LINE COMPUTERS FOR ENVIRONMENTAL RESEARCH ...Acoustical, Development of Models, Hybrid Computer Applications, Meteorological Studies, Water Motion, ...4.0081

AIR OCEANOGRAPHY ...Atlantic Ocean-north, Buoys, Gulf Stream, Satellites, Technique Development, ...4.0163

RADIANT ENERGY FLUX ACROSS THE AIR-SEA INTERFACE AND HEAT BUDGET OF THE OCEANS ...Forecasting-prediction, Heat and Radiation Transfer, Heat Exchange, Radiation-general, Thermal, ...3.0032

MARINE INTERFACE CHEMISTRY ...General Sea Water Chemistry, Organics, Sampling, ...1.0073

LARGE-SCALE INTERACTIONS ...Acoustical, Buoys, Pacific Ocean-north, Temperature, Thermal, ...3.0006

HYDRODYNAMIC EFFECTS OF SUBMERGED BODY ...Fluid Dynamics, Model Studies, Theoretical Analysis, Water Tunnels Tables, ...8.0179

MISCELLANEOUS SERVICES FOR FEDERAL AVIATION AGENCY (VISUAL RANGE) ...Distance-measuring-device, Fog-haze-mist, Visibility, ...3.0011

ATMOSPHERIC TURBULENCE FIELD STUDIES ...Air Motion Instruments, Boundary Layer Studies, Heat Exchange, Turbulence, Velocity, ...3.0020

OCEAN DYNAMICS - OCEANOGRAPHIC ANALYSES AND FORECASTING MODELS ...Acoustical, Hydrodynamics, Model Studies, Surface Environments, Temperature, ...1.0004

HISTORICAL CHARTS AND INTERPRETATION OF CHANGES IN SEA SURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN ...Atlases-maps, Circulation-general, Commercial Fishing, Pacific Ocean-north, Temperature, ...1.0179

ANALYSIS OF THE MARINE LAYER - A MESO METEOROLOGICAL STUDY ...California, Diffusion, Heat Exchange, Orographic Effects, Turbulence, ...3.0001

Air-sea Boundary-other

THE NET EFFECT OF WIND ON RECREATIONAL TIDAL STREAMS IN FLORIDA ...Estuaries, Florida, Tides, Water Level Fluctuation, Wind-general, ...2.0082

Heat and Radiation Transfer

TRITIUM IN HURRICANES ...Aircraft, Heat Exchange, Particle-gas Transfer, Tracers, Tritium, Tropical Cyclones, ...3.0047

INFRARED RADIOMETRY FOR SURFACE HEAT FLOW ...Atmosphere Radiation, Heat Exchange, Infrared Radiation, Technique Development, Temperature, ...4.0153

ARCTIC AIR, SEA AND ICE ...Arctic, Climatography, Heat Exchange, Micrometeorology, Sea Ice, Weather Forecasting, ...3.0088

DELAY LINE COMPUTER ...Acoustical, Hybrid Computer Applications, Meteorological Studies, Model Studies, Water Motion, ...4.0080

AIR-SEA INTERACTION ...Heat Exchange, Latent Heats, Temperature, ...3.0041

HIGH FREQUENCY WAVES ...Forecasting-prediction, Hydrodynamics, Water Motion Recorders, Waves, ...2.0113

PHYSICAL OCEANOGRAPHY ...Convection, Hawaii, Mixing, Thermal, Wind-water Interaction, ...3.0034

THE CONTRIBUTION OF ADVECTION AND LOCAL HEATING TO THE MAINTENANCE OF THE THERMAL STRUCTURE IN THE NORTH PACIFIC OCEAN ...Circulation-general, Convection, Mixing, Pacific Ocean-north, Thermal, ...1.0183

RESEARCH IN AIR-ENERGY EXCHANGE ...Lasers and Masers, Optical, Thermal, Visible, ...3.0035

ENERGY TRANSFER NEAR THE EARTHS SURFACE ...Air Motion Instruments, Buoys, Thermodynamics, Turbulence, ...3.0044

SEA BREEZE INVESTIGATION ...Data Analysis - General, Energy-general, Gulf of Mexico, Land-sea Breezes, Texas, ...3.0040

CLIMATE CHANGE OVER THE POLAR OCEAN ...Arctic Ocean, Heat Budget, Numerical Analysis-other, Physical Climatology, ...3.0058

DEVELOPMENT OF A SIMPLE UNATTENDED PYCNOCLINE FOLLOWER ...Density, Hawaii, Wind-water Interaction, ...8.0091

DYNAMICS OF AIR-SEA INTERACTION ...Meteorological Studies, Particle-gas Transfer, Profiles, Surface Environments, Wind-water Interaction, ...3.0022

TOTAL HEAT FLUX MEASUREMENT WITH A TWO-WAVELENGTH RADIOMETER ...Atmosphere Radiation, Meteorological Studies, ...3.0007

AIR-SEA INTERACTION ...Forecasting-prediction, Meteorological Studies, Thermal, Wind-water Interaction, ...3.0023

HEAT AND MOMENTUM EXCHANGE PROCESSES BETWEEN THE OCEAN AND THE ATMOSPHERE ...General Synoptic Observations, Meteorological Studies, Oregon, Pacific Ocean-east, Wind-water Interaction, ...3.0038

AIR-SEA INTERACTION (WAVES) ...British West Indies, Forecasting-prediction, Surface Environments, Waves, Wind-water Interaction, ...3.0016

EXPERIMENTAL HYDRODYNAMICS ...Fluid Dynamics, Hydrodynamics, Simulation Theory, Submersibles, Thermocline, ...8.0192

DISTRIBUTIONS OF CURRENTS AND PHYSICAL PROPERTIES WITHIN THE ARCTIC OCEAN ...Acoustical, Arctic Ocean, Currents-ocean, Sea Ice, Temperature, ...4.0051

AIR-SEA EXCHANGE ...Albedo, Infrared Radiation, Massachusetts, Temperature, Towers, ...3.0026

MEDITERRANEAN OCEANOGRAPHY ...Convection, Data Analysis - General, Mediterranean Sea-general, Ships and Cruises, Surface Environments, ...4.0132

RADIANT ENERGY FLUX ACROSS THE AIR-SEA INTERFACE AND HEAT BUDGET OF THE OCEANS ...Air-sea Boundary-general, Forecasting-prediction, Heat Exchange, Radiation-general, Thermal, ...3.0032

TURBULENCE OVER WAVES ...Forecasting-prediction, Heat Exchange, Meteorological Studies, Thermal, Turbulence, Waves, ...3.0027

LARGE-SCALE ATMOSPHERIC EVOLUTION ...Heat Budget, Heat Exchange, Meteorologic Model Studies, Meteorological Studies, Weather Forecasting, ...4.0043

SEA-AIR INTERACTION RESEARCH ...Acoustical, Hydrodynamics, Salinity, Waves, ...3.0039

ARCTIC UNDERSEAS RESEARCH, JOINT USA-CANADIAN HEAT BUDGET STUDY ...Arctic, Instrumentation-general, Physical Climatology, Sea Ice, ...3.0071

GREAT LAKES RESEARCH - ENERGY TRANSFER AT THE AIR-WATER INTERFACE ...Data Analysis - General, Heat-transfer-other, Lake Michigan, Mass Transfer, Towers, Wind-water Interaction, ...3.0029

INVESTIGATE SEASONAL VARIATIONS, SURFACE WATER TYPES, HAWAIIAN AREA (KOKO HEAD) ...Commercial Fishing, Hawaii, Oceanic Fronts, Salinity, Temperature, Tuna, Mackerel, Albacore... , Water Salinity, Water Temperature-non-specific, ...1.0148

Particle-gas Transfer

TRITIUM IN HURRICANES ...Aircraft, Heat and Radiation Transfer, Heat Exchange, Tracers, Tritium, Tropical Cyclones, ...3.0047

APPLICATION OF METEOROLOGICAL SATELLITE SENSING TO GENERAL CIRCULATION MODELS ...Infrared Radiation, Meteorologic Model Studies, Patterns, Satellites, Thermodynamics, Weather Forecasting, ...4.0137

AN INVESTIGATION OF TRITIUM IN RAIN WATER ...Atmosphere Composition, Humidity, Precipitation-other, Rain-other, Tritium, ...1.0130

HYDROSPHERE-ATMOSPHERE RADIOCHEMICAL MEASUREMENTS ...Carbon, Diffusion, Nuclear Explosions - Fallout, Tracers, Velocity, ...3.0043

WHITECAPPING ...Meteorological Studies, Temperature, Velocity, Waves, Wind-water Interaction, ...2.0120

LIGHT ISOTOPE STUDIES ...Chemical Reactions, Circulation-general, Deuterium, Isotope Tracer-other, Mixing, Oxygen, ...1.0077

FLUXES OF DISSOLVED GASES AND NUTRIENTS RELATING TO BIOCHEMICAL AND AERATION PROCESSES OFF THE OREGON COAST ...Chemical Analysis (water), Gases, Oregon, Organics, Phosphate, Phosphite, ...3.0037

OCEAN-ATMOSPHERE STUDIES WITH STABLE ISOTOPES AND DISSOLVED GASES ...Air-sea Boundary-general, Equilibrium - Chemical, Gases, Mixing, Oceanic Fronts, Tracers, ...3.0005

MASS SPECTROMETRIC AND MANOMETRIC STUDIES OF THE OCEANS AND THE ATMOSPHERE ...Chemical Analysis (water), Gases, Mass Spectroscopy, Ocean History, Solubility, ...1.0101

STUDIES IN THE INDIAN OCEAN ...Circulation-general, Data Analysis - General, Indian Ocean-general, Storms-general, ...2.0073

STUDY OF THE EXCHANGE OF CARBON DIOXIDE BETWEEN THE ATMOSPHERE AND THE OCEANS ...Carbon, Computer Applications, Gases, Meteorological Studies, ...1.0081

TRITIUM IN HURRICANES ...Air Pollution Sampling, Atlantic Ocean-general, Sampling, Tritium, Tropical Cyclones, ...3.0018

DYNAMICS OF AIR-SEA INTERACTION ...Heat and Radiation Transfer, Meteorological Studies, Profiles, Surface Environments, Wind-water Interaction, ...3.0022

PRECISION MEASUREMENTS OF DISSOLVED OXYGEN, NITROGEN AND ARGON IN SEAWATER ...Argon, Gases, Nitrogen, Oxygen, Solubility, Special Mission Ships, ...1.0092

PHYSICAL CHEMISTRY OF BUBBLES ...Bubble, Diffusion, Interface, Surface Energy, ...1.0082

STUDIES IN MARINE CHEMISTRY ...Bone, Chemistry, Trace Elements, ...7.0068

EVAPORATION OF WATER ...Evaporation, Humidity, Humidity Instruments, ...3.0012

FALLOUT INVENTORY OF THE OCEANS AND RELATED MECHANISMS ...Activation Analysis, Radioactivity, Radioactivity-general, Trace Elements, ...6.0189

Wind-water Interaction

DEVELOPMENT OF PHYSICAL-NUMERICAL MODELS FOR STUDIES OF THE ATMOSPHERE-OCEAN PLANETARY BOUNDARY LAYER ...Advection, Mixing, Simulation Theory, Thermal, Turbulence, ...3.0010

AIR-SEA INTERACTION PROCESS ...Boundary Layer Studies, Buoys, Circulation-general, Lakes, Profiles, ...3.0028

AMBIENT SEA NOISE INVESTIGATION ...Acoustic, Acoustical, Computer Applications, Noise, Waves, ...1.0048

HIGH FREQUENCY OCEAN WAVES ...Aircraft, Forecasting-prediction, Photogrammetry, Radar, Waves, ...2.0121

WHITECAPPING ...Meteorological Studies, Particle-gas Transfer, Temperature, Velocity, Waves, ...2.0120

PHYSICAL OCEANOGRAPHY ...Convection, Hawaii, Heat and Radiation Transfer, Mixing, Thermal, ...3.0034

OCEAN WAVES ...Model Studies, Profiles, Temperature, Waves, Waves-internal, ...3.0004

DESCRIPTIVE OCEANOGRAPHY ...Circulation-general, Currents-ocean, Data Analysis - General, Pacific Ocean-east, ...4.0116

A STUDY OF PROBLEMS RELATED TO WIND-GENERATED WAVES ...Free Surface Waves, Laminar - Turbulent, Theoretical Analysis, Waves, ...4.0088

WAVE, CURRENT AND STORM SURGE RESPONSE TO EXTREME WIND CONDITIONS ...Currents-ocean, Forecasting-prediction, Model Studies, Storms-general, Waves, ...2.0107

EXPERIMENTAL FLUID DYNAMICS ...Laminar - Turbulent, Model Studies, Rotating Fluids, Shear-flow, Thermodynamics, ...3.0021

EXPERIMENTS IN AIR-SEA INTERACTION INVOLVING SURFACE PRESSURE MEASUREMENTS ...Air Motion-other, Pressure-density, Wind-other, ...3.0017

DEVELOPMENT OF A SIMPLE UNATTENDED PYCNOCLINE FOLLOWER ...Density, Hawaii, Heat and Radiation Transfer, ...8.0091

CIRCULATION AROUND OCEANIC ISLANDS ...Circulation-general, Density, Islands, Mixing, Thermodynamics, Waves-internal, ...2.0010

OPTICAL OCEANOGRAPHY IN FLORIDA BAY, FLORIDA STRAITS AND BAHAMA BANK ...Distribution, Mixing, Optical, Optical Devices, Sedimentation, ...1.0163

EXPERIMENTAL STUDY OF THE INTERRELATIONS BETWEEN WIND-WAVE PROPERTIES ...Hydrodynamics, Mixing, Pressure, Turbulence - Sea Water, Waves, ...2.0123

RESEARCH IN OCEANIC PHYSICS ...Atlantic Ocean-south, Convection, Mixing, Oceanic Fronts, Thermodynamics, ...2.0059

LINE ISLANDS EXPERIMENT ...Boundary Layer Studies, General Synoptic Observations, Line Islands, Physical Climatology, Satellites, ...3.0063

DYNAMICS OF AIR-SEA INTERACTION ...Heat and Radiation Transfer, Meteorological Studies, Particle-gas Transfer, Profiles, Surface Environments, ...3.0022

TRANSPORT PROCESSES ACROSS AN AIR-WATER INTERFACE ...Air-sea Boundary-general, Model Studies, Statistics-general, ...3.0003

THEORY OF LARGE-SCALE ATMOSPHERIC AND OCEANIC PROCESSES ...Circulation-general, Currents-ocean, Model Studies, Tropic, Weather Forecasting, ...2.0070

(U) OCEAN CIRCULATION MODELS ...Circulation-general, Currents-ocean, Model Studies, Shear, Waves, ...2.0024

AIR-SEA INTERACTION ...Forecasting-prediction, Heat and Radiation Transfer, Meteorological Studies, Thermal, ...3.0023

HEAT AND MOMENTUM EXCHANGE PROCESSES BETWEEN THE OCEAN AND THE ATMOSPHERE ...General Synoptic Observations, Heat and Radiation Transfer, Meteorological Studies, Oregon, Pacific Ocean-east, ...3.0038

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Algae- Dinoflagellates

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LAKE BORGNO - CHANDELEUR SOUND SYSTEM ...Data Acquisition, Gulf of Mexico, Nets, Plankton Sampling, Population Dynamics, Shrimps - Common, ...**5.0434**

FORECAST OF KODIAK ISLAND PINK SALMON RUNS FROM ABUNDANCE OF JUVENILES IN ESTUARIES ...Alaska, Estuaries, Fishing Gear, Migration, Number Or Density, Salmon -coho,chinook,sockeye.., ...**5.0179**

POPULATION ESTIMATES OF JUVENILE COHO SALMON IN SIX COASTAL STREAMS ...Environmental Ecology, Population Dynamics, Salmon -coho,chinook,sockeye.., Streams, ...**5.0144**

DISTRIBUTION OF YOUNG STAGES OF COASTAL FISHES ...Continental Shelf, Estuaries, Fish -non-specific, Number Or Density, Ships and Cruises, ...**5.0119**

INFLUENCE OF THE PHYSICAL ENVIRONMENT ON DISTRIBUTION OF YOUNG STAGES OF COASTAL GAME FISH ...Continental Shelf, Environmental Ecology, Fish -non-specific, Physical-general, Range Or Territorial Distr. , ...**5.0211**

METHODS OF REARING EGGS AND LARVAE TO JUVENILE STAGES ...Aquaculture & Fish-farming, Captive Rearing, Environmental Physiology, Fish -non-specific, ...**8.0010**

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...Basic Embryology, Behavior, Clams, Oysters, Ph, Ac[illegible]ater, ...**5.0373**

ECOLOGICAL FACTORS AFFECTING REPRODUCTION OF SHELLFISH (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...Animal Distr. (non-specific), New York, Oysters, Reproductive System, Spawning & Nesting Sites, ...**5.0374**

SURVIVAL REQUIREMENTS OF JUVENILE AND ADULT BLUE CRABS ...Biological Rhythms, Crabs, Environmental Physiology, Osmoregulation, Salinity, Size, ...**5.0475**

ESTIMATION OF JUVENILE ABUNDANCE IN ESTUARINE NURSERIES ...Alewife,menhaden,shad,herring, Aquatic Ecology, Estuaries, Gulf of Mexico, Number Or Density, ...**5.0131**

ESTUARINE BIOLOGY--RESPONSE OF LARVAE TO TEMPERATURE AND SALINITY ...Alewife,menhaden,shad,herring, Captive Rearing, Estuaries, Longevity, Low Temp. -but Above 32f, Water Salinity, ...**5.0213**

PINK SALMON INVESTIGATIONS - FRESHWATER ECOLOGY ...Aquatic Ecology, Environmental Ecology, Mortality Rates, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, ...**5.0188**

EFFECTS OF CHEMICALS ON THE PHYSIOLOGY OF SEA LAMPREY AMMOCETES (PETROMYZON MARINUS)

...Contamination - Water, Control of Nuisance Species, Environmental Physiology, Lampreys, ...**5.0631**

INVESTIGATE SYSTEMATICS AND ECOLOGY OF TUNA LARVAE AND JUVENILES ...Animal Taxonomy, Artifical Insemination, Spawning & Nesting Sites, Tuna, Mackerel, Albacore... , ...**5.0079**

EARLY LIFE HISTORY OF COREGONIDS ...Cisco, Lake Herring, Environmental Ecology, Life History Studies, Technique Development, Water Environment -other, ...**5.0110**

BEHAVIOR OF LARVAL FISHES ...Behavior, Captive Rearing, Commercial Fishing, Environmental Physiology, Fish -non-specific, ...**5.0062**

CONTRIBUTIONS TO THE BIOLOGY OF THE ROYAL RED SHRIMP, HYMENOPENAEUS ROBUSTUS ...Atlantic Ocean-south, Number Or Density, Shrimps - Common, Vertical Distribution, ...**5.0421**

PACIFIC FISH PHYSIOLOGY AND BIOCHEMISTRY (SALMON IMMUNOCHEMISTRY) ...Immunology, Salmon - coho,chinook,sockeye.., Stress, ...**5.0332**

SYSTEMATICS OF CARANGID FISHES ...Animal Taxonomy, Collections, Handbooks, Pompanos, Scads, Jacks, Species, Comparison of , ...**5.0061**

SPECIES LIFE HISTORY AND DISTRIBUTION ...California Current, Fish -non-specific, Life History Studies, Number Or Density, Oceanic Fronts, ...**5.0037**

FISH HOLDING AND LIFE STAGE SENSITIVITY STUDIES ...Contamination - Water, Environment Resistance, Fish, Fish - non-specific, Great Lakes-general, ...**5.0276**

DEVELOPMENTAL STUDIES OF SELECTED INVERTEBRATES ...Basic Embryology, Developmental Physiology, Hatchability, Size, ...**5.0958**

Mortality Rates

SIMULATION STUDIES OF ECOLOGICAL COMMUNITIES ...Number Or Density, Population Dynamics, Predation, Productivity - Food Chain, ...**5.0862**

MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...Bays, Environmental Ecology, Oysters, Pathology, Puget Sound, ...**5.0510**

INVESTIGATE THE CAUSE OF MORTALITY OF PACIFIC OYSTERS ALONG THE CALIFORNIA COAST ...California, Environmental Ecology, Oysters, Pathology, Training Grants, Fellowships, ...**5.0360**

MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...Bays, Invertebrate Pathology, Oregon, Oysters, Pathology, ...**5.0488**

STUDIES IN OYSTER PATHOLOGY ...Invertebrate Pathology, Oysters, Pathology, Tissues, ...**5.0519**

KVICHAK RIVER TOTAL SMOLT ...Alaska, Censusing, Fish - non-specific, Migration, Nets, Population Dynamics, ...**5.0002**

BIOLOGY OF ANADROMOUS ALOSIDS ...Alewife,menhaden,shad,herring, Spawning & Nesting Sites, Streams, Tidal Streams, Virginia, ...**5.0150**

WATER QUALITY AS RELATED TO SURVIVAL OF SALMON EGGS AND LARVAE ...Environmental Ecology, Reproduction Studies (general), Salmon & Trout - Non-specific, Spawning & Nesting Sites, Water Quality-general, ...**5.0227**

EARLY LIFE OF BOREAL FOOD FISH AND SHELLFISH ...Animal Taxonomy, Fish -non-specific, Life History Studies, Mollusks -non-specific & Other, ...**5.0139**

DISTRIBUTION, AGE GROWTH, AND MORTALITY STUDIES OF SALT WATER FISHES OF IMPORTANCE TO SPORT FISHERMEN ...Age, Chesapeake Bay, Drums, Growth Rate, Vertical Distribution, ...**5.0155**

TEMPERATURE TOLERANCE OF MARINE ANIMALS THROUGH BEHAVORIAL RESPONSES ...Behavior, Environment Resistance, Thermal, Water Temperature-non-specific, ...**5.0118**

EVALUATION OF THE ATLANTIC FLYWAY SEA DUCK KILL ...Age, Anseriformes -other, Hunting, Sex -non-specific, Species, Comparison of , ...**5.0606**

KARLUK LAKE RESEARCH STATION ...Life History Studies, Population Dynamics, Productivity (agricultural), Salmon - coho,chinook,sockeye.., Spawning & Nesting Sites, ...**5.0006**

PINK SALMON INVESTIGATIONS - FRESHWATER ECOLOGY ...Aquatic Ecology, Environmental Ecology, Maturity & Growth Stages, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, ...**5.0188**

FUR SEAL RESEARCH, ANATOMY-BEHAVIOR-MORTALITY ...Behavior, Hair, Nutrition -other, Seals, Vertebrate Anatomy, ...**5.0672**

OCEAN GROWTH AND MORTALITY OF SALMON ...Growth Rate, Salmon -coho,chinook,sockeye.., Scales, Tags, ...**5.0170**

DROPOUT OF SALMON FROM GILL NETS ...Commercial Fishing, Management -other, Nets, Salmon & Trout - Non-specific, Water Salinity, ...**5.0177**

EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...Aquatic Ecology, Columbia River, Gases, Dissolved -water, Migration, Nitrogen, Salmon & Trout - Non-specific, ...**5.0221**

PROTECTION OF FINGERLING SALMON IN TURBINES ...Construction Land Use Effects, Engineering Structures-general, Migration, Salmon & Trout - Non-specific, Snake River, ...**8.0014**

POPULATION DYNAMICS (SHRIMP DYNAMICS PROGRAM) ...Commercial Fishing, Gulf of Mexico, Nets, Population Dynamics, Shrimps - Common, ...**5.0503**

PATHOLOGY - EPIZOOTIOLOGY ...Epizootiology, Oysters, Pathology, Protozoa, Protozoa -other, ...**5.0441**

PACIFIC OYSTER MORTALITY STUDIES ...Invertebrate Pathology, Oysters, Pacific Ocean-general, Pathology, ...**5.0442**

EPIZOOTICS IN EXPERIMENTAL MARINE SHELLFISH POPULATIONS ...Epizootic, Freshwater Mussels, Scallops, Oysters, Pathology, ...**5.0520**

Number Or Density

HYDROGRAPHIC AND BIOLOGICAL SURVEY OF MONTSWEAG BAY AND VICINITY ...Bays, Maine, Organism Sampling Devices, Vertical Distribution, Zooplankton, ...**5.0893**

RADIOELEMENT STUDIES IN THE OCEANS- PLANKTON DISTRIBUTION STUDIES ...Chemical Reactions, Foraminifera, Protozoa -other, Vertical Distribution, ...**5.0795**

SEASONAL DISTRIBUTION AND ABUNDANCE OF DEMERSAL FISH AND INVERTEBRATES IN THE MARINE WATERS ADJACENT TO THE MOUTH OF THE COLUMBIA RIVER ...Benthic Fauna, Productivity - Food Chain, Radioactivity-general, Temporal Distribution, Vertical Distribution, ...**5.0930**

RESEARCH ON INDO-WEST PACIFIC MARINE MOLLUSKS OF THE FAMILY CONIDAE ...Animal Taxonomy, Gastropods -slugs,conch,snails, Indian Ocean-general, Invertebrate Anatomy, ...**5.0517**

DYNAMICS OF OCEANIC PLANKTON ...Growth Rate, Productivity (agricultural), RNA , Zooplankton, ...**5.0825**

ICHTHYOFAUNA OF THE FLORIDA CURRENT ...Fish -non-specific, Florida, Temporal Distribution, Vertical Distribution, ...**5.0066**

RESEARCH IN MARINE BENTHIC ECOLOGY OFF OREGON ...Benthic Fauna, Environmental Ecology, Oregon, Vertical Distribution, ...**5.0916**

SIMULATION STUDIES OF ECOLOGICAL COMMUNITIES ...Mortality Rates, Population Dynamics, Predation, Productivity - Food Chain, ...**5.0862**

BIOLOGY OF THE DEEP-SEA BENTHOS ...Atlantic Ocean-general, Benthic Fauna, Tropic, Vertical Distribution, ...**5.0902**

AIR-SEA INTERACTION AND PLANKTON ECOLOGY ...Circulation-general, Environmental Ecology, Marine Biology (non-specific), Plankton (non-specific), ...**4.0078**

BENTHONIC BIOLOGY ...Benthic Organisms (non-specif), Environmental Ecology, Fouling, Marine Biology (non-specific), Temporal Distribution, ...**5.0900**

PRELIMINARY STUDY TO DETERMINE ABUNDANCE AND RECRUITMENT OF BOTTOMFISH OFF OREGON ...Nets, Oregon, Pacific Ocean-general, Righteye Flounders, ...**5.0136**

TAG DETECTION ...Commercial Fishing, Puget Sound, Salmon - coho,chinook,sockeye.., Streams, Tags, ...**8.0148**

A STUDY OF THE SEASONAL ABUNDANCE, DISTRIBUTION AND SPECIES COMPOSITION, WITH DEPTH, OF NEKTON FAUNA, WITH PARTICULAR EMPHASIS ON FISHES ...Fish -non-specific, Life History Studies, Vertical Distribution, Zooplankton, ...**5.0114**

SEASONAL ABUNDANCE AND BIOLOGICAL STABILITY OF THE COMMERCIAL SHRIMP OF GEORGIA ...Commercial Fishing, Shrimps - Common, ...**5.0419**

PRE-EMERGENT FRY PINK SALMON FORECAST - SOUTHEASTERN ALASKA ...Alaska, Aquatic Ecology, Censusing, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, ...**5.0019**

OFFSHORE SALMON ABUNDANCE INDEX ...Alaska, Commercial Fishing, Salmon -coho,chinook,sockeye.., Streams, ...**5.0028**

MEASUREMENT OF SPAWNING SUCCESS AND FRY QUALITY OF CHUM SALMON UTILIZING A SPAWNING CHANNEL AT BIG BEEF CREEK, WASHINGTON ...Management -other, Quality -non-specific, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, Washington, ...**5.0229**

FISH POPULATION OFF THE ISLAND OF TUTUILA, AMERICAN SAMOA ...American Samoa, Animal Taxonomy, Commercial Fishing, Fish -non-specific, Fishing Gear, ...**5.0032**

FISH POPULATIONS OF AMERICAN SAMOA ...American Samoa, Crustacea -non-specific, Fish -non-specific, Fishing Gear, ...**5.0033**

LAKE BORGNE-CHANDELEUR SOUND SYSTEM ...Benthic Fauna, Louisiana, Plankton Sampling, River Deltas, Vertical Distribution, ...**5.0091**

TIMBALIER - TERREBONNE BAYS SYSTEM ...Benthic Fauna, Louisiana, Plankton Sampling, River Deltas, Vertical Distribution, ...**5.0092**

BRETON SOUND - MOUTH OF MISSISSIPPI RIVER SYSTEM ...Benthic Fauna, Louisiana, Plankton Sampling, River Deltas, Vertical Distribution, ...**5.0093**

VERMILION - CALCASIEU - SABINE SYSTEM ...Benthic Fauna, Louisiana, Plankton Sampling, Salinity, Tides, Vertical Distribution, ...**5.0094**

ATCHAFALAYA RIVER - GAILOU LAKE SYSTEM ...Benthic Fauna, Lakes, Louisiana, Plankton Sampling, Vertical Distribution, ...**5.0095**

BIOLOGICAL EVALUATION OF EACH EXISTING SEED OYSTER BED IN DELAWARE BAY ...Delaware Bay, Fouling, Oysters, Spawning & Nesting Sites, ...**5.0382**

PRE-EMERGENT FRY PINK SALMON FORECAST (KODIAK, ALASKA) ...Alaska, Maturity & Growth Stages, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, Streams, ...**5.0017**

KVICHAK RIVER SMOLT STUDY LITERATURE SURVEY ...Alaska, Censusing, Fish -non-specific, Migration, Survey Studies, ...**5.0003**

TAGGING PROGRAM ...Lobsters, Long Island Sound, Population Dynamics, Tags, Temporal Distribution, ...**5.0372**

SAMPLING OF MARKED COHO ...Censusing, Columbia River, Mark, Tag Or Capture -other, Salmon -coho,chinook,sockeye.., Stocking of Fish & Shellfish, ...**5.0162**

DESIGN OF SAMPLING PLAN AND PROCUREMENT OF CHARTER VESSEL ...Commercial Fishing, Continental Shelf, Fish -non-specific, Nets, Vertical Distribution, ...**4.0014**

FORECAST OF KODIAK ISLAND PINK SALMON RUNS FROM ABUNDANCE OF JUVENILES IN ESTUARIES ...Alaska, Estuaries, Fishing Gear, Maturity & Growth Stages, Migration, Salmon -coho,chinook,sockeye.., ...**5.0179**

TAGGING SALMON IN THE OFFSHORE WATERS OF THE NORTH PACIFIC ...Bering Sea, Gulf of Alaska, Migration, Range Or Territorial Distr. , Salmon & Trout - Non-specific, Tags, ...**5.0180**

A NON-DESTRUCTIVE METHOD FOR ESTIMATING POPULATION DENSITY AND DISTANCE TO NEAREST NEIGHBOR FOR ESTUARINE MOLLUSCS ...Aquatic Ecology, Estuaries, Mollusks -non-specific & Other, Population Dynamics, Range Or Territorial Distr. , ...**5.0439**

SHELLFISHERIES RESEARCH ...Clams, Commercial Fishing, Crabs, Life History Studies, Oysters, ...**5.0383**

ECOLOGY OF COMMERCIAL FISH SPECIES IN NORTHERN LAKE MICHIGAN ...Commercial Fishing, Fish -non-specific, Lake Michigan, Population Dynamics, Vertical Distribution, ...**5.0112**

EVALUATION OF ESCAPEMENT OF ADULT SALMON TO OREGON COASTAL STREAMS ...Environmental Ecology, Oregon, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, Streams, ...**5.0215**

SURVEYS OF SPAWNING SALMON ...Biological Rhythms, Censusing, Oregon, Salmon & Trout - Non-specific, Streams, ...**5.0142**

DISTRIBUTION AND ABUNDANCE OF OYSTER DRILLS (UROSALPINX CINEREA) IN THE JAMES RIVER, VIRGINIA ...Aquatic Ecology, Gastropods -slugs,conch,snails, Streams, Vertical Distribution, Virginia, ...**5.0508**

FORAMINIFERA FROM HEDLEY HARBOR, MASSACHUSETTS ...Environmental Ecology, Foraminifera, Harbors, Massachusetts, Vertical Distribution, ...**5.0563**

STUDY OF NORTH AND EQUATORIAL ATLANTIC PLANKTONIC FORAMINIFERA ...Foraminifera, Oceanic Fronts, Organism Sampling Devices, Vertical Distribution, ...**5.0764**

PATTERNS OF SPECIES DIVERSITY - TERTIARY-RECENT ...Cenozoic Era-general, Foraminifera, Geographical Relations, Population - Distribution, Speciation, ...**5.0564**

THE CEPHALOPODS OF THE CENTRAL PACIFIC ...Octopus, Squid, Cuttlefish... , Vertical Distribution, ...**5.0399**

THE SYSTEMATICS AND DISTRIBUTION OF THE WORLD-WIDE SQUID FAMILY BATHYTEUTHIDAE ...Animal Taxonomy, Life History Studies, Octopus, Squid, Cuttlefish... , World Wide, ...**5.0400**

DISTRIBUTION OF YOUNG STAGES OF COASTAL FISHES ...Continental Shelf, Estuaries, Fish -non-specific, Maturity & Growth Stages, Ships and Cruises, ...**5.0119**

ABUNDANCE AND MIGRATION STUDIES OF THE WHITE SEAPERCH (P. FURCATUS), PILE PERCH (R. VACCA), STRIPED SEAPERCH (E. LATERALIS) AND STARRY FLOU ...Environmental Ecology, Fish -other, Migration, Oregon, Righteye Flounders, ...**5.0934**

ABUNDANCE AND AVAILABILITY OF PRE-RECRUIT HERRING ...Alewife,menhaden,shad,herring, Aquatic Ecology, Environmental Ecology, Life History Studies, Vertical Distribution, ...**5.0208**

EFFECT OF ENVIRONMENTAL CHANGES ON BLUE CRAB ABUNDANCE ...Crabs, Environmental Ecology, Life History Studies, Migration, Population Dynamics, ...**5.0473**

ESTIMATION OF JUVENILE ABUNDANCE IN ESTUARINE NURSERIES ...Alewife,menhaden,shad,herring, Aquatic Ecology, Estuaries, Gulf of Mexico, Maturity & Growth Stages, ...**5.0131**

SAMPLING OF THE ATLANTIC COMMERCIAL CATCH ...Alewife,menhaden,shad,herring, Atlantic Ocean-general, Commercial Fishing, Nets, ...**5.0129**

NAKNEK SYSTEM RED SALMON STUDIES ...Alaska, Growth Rate, Migration, Salmon -coho,chinook,sockeye.., Streams, ...**5.0005**

CHUM SALMON INVESTIGATIONS ...Environmental Ecology, Estuaries, Food Supply, Growth Rate, Life History Studies, Salmon -coho,chinook,sockeye.., ...**5.0007**

INTERRELATIONS OF SMELT WITH NATIVE SPECIES ...Competition, Food Supply, Lake Superior, Life History Studies, Smelts, ...**5.0182**

FISHES TAKEN INCIDENTAL TO SHRIMP TRAWLING ...Atlantic Ocean-south, Fish -non-specific, Nets, Shrimps - Common, ...**5.0072**

MARINE BIOLOGICAL INVESTIGATIONS - SURFACE ZOOPLANKTON PROJECT ...Alaska, Plankton Sampling, Vertical Distribution, Zooplankton, ...**5.0737**

ESTUARINE STUDIES OF SOUTHEASTERN ALASKA ...Alaska, Benthic Fauna, Environmental Ecology, Estuaries, Vertical Distribution, ...**5.0852**

CONTRIBUTIONS TO THE BIOLOGY OF THE ROYAL RED SHRIMP, HYMENOPENAEUS ROBUSTUS ...Atlantic Ocean-south, Maturity & Growth Stages, Shrimps - Common, Vertical Distribution, ...**5.0421**

GROUNDFISH INVESTIGATIONS (POTENTIAL YIELD OF UNDERUTILIZED GROUNDFISH STOCKS) ...Codfishes, Hake, Commercial Fishing, Legislation, Rockfish, Scoraionfish, ...**5.0171**

ANALYSIS OF JAPANESE CATCH STATISTICS ...Commercial Fishing, Japan, Pacific Ocean-north, Salmon -coho,chinook,sockeye.., ...**5.0166**

POPULATION DYANMICS (BIOMETRICS) OF EXPLOITED FISH GROUPS OF THE NORTH PACIFIC OCEAN AND PACIFIC COAST ...Marine Biology, Meteorological Studies, Model Studies, Pacific Ocean-north, Population Dynamics, ...**5.0167**

THE OCEANOGRAPHY OF NEW ENGLAND FISHING BANKS ...Continental Shelf, Fish -other, Vertical Distribution, Water Environment -other, ...**5.0901**

PRODUCTIVITY MEASURES ...Ocean Currents-other, Organism Sampling Devices, Pacific Ocean-east, Primary Productivity, Productivity - Food Chain, Zooplankton, ...**5.0940**

SPECIES LIFE HISTORY AND DISTRIBUTION ...California Current, Fish -non-specific, Life History Studies, Maturity & Growth Stages, Oceanic Fronts, ...**5.0037**

Productivity (agricultural)

DYNAMICS OF OCEANIC PLANKTON ...Growth Rate, Number Or Density, RNA , Zooplankton, ...**5.0825**

PRODUCTIVITY OF OCEANIC POPULATIONS OF VERTICALLY MIGRATING ANIMALS ...Migration, Plankton (non-specific), Population Dynamics, Vertical Distribution, ...**5.1019**

COOK INLET SMOLT ENUMERATION STUDY ...Alaska, Censusing, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, ...**5.0015**

ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST ...Commercial Fishing, Fish & Shellfish, Market Structure, Marketing, Math Models, Northeast, ...**6.0151**

CONSTRUCTION OF A NEW SERIES OF SMALL REPLICATION PONDS AND RESEARCH ON THE FACTORS LIMITING FISH PRODUCTION IN IMPOUNDED WATERS ...Aquaculture & Fish-farming, Ponds, ...**8.0001**

CULTURE OF ATLANTIC CROAKER IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Brackish Water, Captive Rearing, Drums, Management, Ponds, ...**8.0005**

SPRING CHINOOK SALMON ECOLOGY STUDY ...Aquatic Ecology, Mark, Tag Or Capture -other, Oregon, Physical-general, Salmon -coho,chinook,sockeye.., Streams, ...**5.0218**

KARLUK LAKE RESEARCH STATION ...Life History Studies, Mortality Rates, Population Dynamics, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, ...**5.0006**

GULF OF ALASKA DEMERSAL FISH INVESTIGATIONS ...Fish -non-specific, Gulf of Alaska, Population Dynamics, Vertical Distribution, ...**5.0009**

Quality -non-specific

SYSTEMS ENGINEERING AND DEVELOPMENT OF COMMERCIALLY VALUABLE MARINE RESOURCES IN THE DELAWARE AREA ...Aquaculture & Fish-farming, Commercial Fishing, Delaware, Fish & Shellfish, Oysters, ...**8.0002**

MEASUREMENT OF SPAWNING SUCCESS AND FRY QUALITY OF CHUM SALMON UTILIZING A SPAWNING CHANNEL AT BIG BEEF CREEK, WASHINGTON ...Management -other, Number Or Density, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, Washington, ...**5.0229**

ESTIMATING THE VALUE ADDED TO SEAFOOD PRODUCTS LANDED IN GEORGIA AT THE VARIOUS STAGES OF THE MARKETING CHANNEL ...Fish -non-specific, Georgia, Processing, Shellfish -non-specific, ...**6.0020**

Sex

Female

METABOLIC ADAPTATION TO COLD ...Cold, Hypothermia, Korea, Metabolism in Disease, Regulation, ...**6.0092**

EVOLUTION OF ALL-FEMALE FISHES ...Gambusia, Molly, Other, Reproduction Studies (general), ...**5.0247**

ISOLATION AND FUNCTION OF OVARIAN EXTRACTS CAPABLE OF INDUCING COCYTE SHEDDING AND OCYTE NUCLEAR MATURATION IN STARFISH ...Differentiation Mechanism, Hormones, Nucleic Acids, Reproductive System, Starfishes, ...**5.0620**

Sex -non-specific

COOK INLET CATCH AND ESCAPEMENT AGE AND SEX COMPOSITION STUDIES ...Age, Alaska, Migration, Nets, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, ...**5.0014**

EVALUATION OF THE ATLANTIC FLYWAY SEA DUCK KILL ...Age, Anseriformes -other, Hunting, Mortality Rates, Species, Comparison of , ...**5.0606**

Size

EXPERIMENTAL STUDIES OF BEHAVIOR IN A CICHLID FISH ...Behavior, Parental Care, Sex, Tilapia, Cichlids, ...**5.0232**

TAGGING ENGLISH SOLE, PETRALE SOLE, AND PACIFIC COD ...Codfishes, Hake, Commercial Fishing, Migration, Righteye Flounders, Tags, Washington, ...**5.0158**

TAG LOSS ...Captive Rearing, Salmon -coho,chinook,sockeye.., Tags, Washington, Weight, ...**5.0157**

EVALUATE THE RESEARCH TECHNIQUES WHICH WILL BE EMPLOYED TO STUDY THE BASIC LIFE HISTORY OF THE RED CRAB (GERYON QUINQUEDENS) ...Age, Crabs, Mark, Tag Or Capture -other, Maturity & Growth Stages, ...**5.0494**

SAMPLING OF GROUNDFISH STOCKS ...Age, Bone, Codfishes, Hake, Proprioceptors, Righteye Flounders, ...**5.0160**

POPULATION STRUCTURE OF THE LOBSTER ...Commercial Fishing, Diving and Scuba, Lobsters, Long Island Sound, Population Dynamics, ...**5.0688**

RELATIONSHIP BETWEEN WATER TEMPERATURE AND SIZE OF PARASITIC COPEPODS ...Collections, Copepods, Host Specificity, Temperature, Water Temperature-non-specific, ...**5.0390**

SURF CLAM POPULATION DYNAMICS ...Age, Clams, Commercial Fishing, Continental Shelf, Population Dynamics, ...**5.0448**

SURVIVAL REQUIREMENTS OF JUVENILE AND ADULT BLUE CRABS ...Biological Rhythms, Crabs, Environmental Physiology, Maturity & Growth Stages, Osmoregulation, Salinity, ...**5.0475**

FLUCTUATIONS IN SPECIES COMPOSITION AND YEAR-CLASS STRENGTH OF COMMERCIAL LANDINGS ...Commercial Fishing, Lake Erie, Lakes, Scales, Species, Comparison of , ...**5.0135**

YOUNG FISHES OF A TIDAL ZONE ...Estuaries, Fish -non-specific, Habitat Studies, Life History Studies, Temporal Distribution, ...**5.0073**

ASSESSMENT OF CENTRAL PACIFIC TUNA RESOURCES ...Commercial Fishing, Pacific Ocean-general, Population Dynamics, Tuna, Mackerel, Albacore... , ...**5.0082**

FISH POPULATION PARAMETERS ...Age, Biological Rhythms, Life History Studies, Population Dynamics, ...**5.0039**

DEVELOPMENTAL STUDIES OF SELECTED INVERTEBRATES ...Basic Embryology, Developmental Physiology, Hatchability, Maturity & Growth Stages, ...**5.0958**

Species, Comparison of

EVALUATION OF THE ATLANTIC FLYWAY SEA DUCK KILL ...Age, Anseriformes -other, Hunting, Mortality Rates, Sex -non-specific, ...**5.0606**

FLUCTUATIONS IN SPECIES COMPOSITION AND YEAR-CLASS STRENGTH OF COMMERCIAL LANDINGS ...Commercial Fishing, Lake Erie, Lakes, Scales, Size, ...**5.0135**

SYSTEMATICS OF CARANGID FISHES ...Animal Taxonomy, Collections, Handbooks, Maturity & Growth Stages, Pompanos, Scads, Jacks, ...**5.0061**

Stress

ECOLOGICAL EFFECTS OF ENVIRONMENTAL & LOW LEVEL POLLUTION STRESSES ON METABOLIC REQUIREMENTS FOR GROWTH OF GULF COAST FISHES ...Environmental Ecology, Gulf of Mexico, Metabolism, Pollution - Effects of , Pollution Effects, Pollution Sources-general, ...**5.0328**

MARINE ECOLOGICAL STUDIES ...Environmental Ecology, Habitat Studies, Intertidal Areas, Invertebrates -non-specific, ...**5.0917**

PACIFIC FISH PHYSIOLOGY AND BIOCHEMISTRY (SALMON IMMUNOCHEMISTRY) ...Immunology, Maturity & Growth Stages, Salmon -coho,chinook,sockeye.., ...**5.0332**

PHARMACOLOGY OF METAL POISONING IN ESTUARINE FISHES ...Contamination - Water, Estuaries, Killifishs - Cyprinodon, Metals -non-specific, ...**5.0324**

Weight

TAG LOSS ...Captive Rearing, Salmon -coho,chinook,sockeye.., Size, Tags, Washington, ...**5.0157**

Animal Parasitology

Ectoparasites

PARASITIC COPEPODA %CRUSTACEA*ROM INVERTEBRATES AND FISHES ...Animal Taxonomy, Copepods, Indian Ocean-general, Invertebrate Anatomy, ...5.0451*

COPEPOD CRUSTACEANS PARASITIC ON FISHES ...Collections, Copepods, Fish -non-specific, Indian Ocean-general, Ships and Cruises, Vertical Distribution, ...**5.0368**

PARASITES OF ANTARCTIC VERTEBRATES AND INVERTEBRATES ...Animal Taxonomy, Antarctic Ocean, Collections, Endoparasites -other, ...**5.0658**

COPEPODS PARASITIC ON NEEDLEFISHES ...Aquatic Ecology, Copepods, Fish -other, Nomenclature, Classification, Organic Evolution, ...**5.0389**

COPEPODS PARASITIC ON SHARKS OF THE WEST COAST OF FLORIDA ...Animal Taxonomy, Copepods, Florida, Sharks, ...**5.0391**

SYSTEMATICS OF CALIGOID COPEPODS ...Animal Taxonomy, Copepods, Host Specificity, Nomenclature, Classification, ...5.0392

LIFE HISTORY OF THE SHARK COPEPOD, KROYERIA DISPAR ...Copepods, Developmental Physiology, Life History Studies, Whole Body Culture & Rearing, ...5.0393

THE ROLE OF THE SENORITA, OXYJULIS CALIFORNICA, AS A CLEANING ORGANISM ...California, Fish -other, Fishery Development -other, Interbiotic Relat.(non-specif), ...5.0193

LAKE HURON CHEMICAL CONTROL ...Bioindicators, Chemical-general, Flow Characteristics -water, Lake Huron, Selectivity, ...6.0159

Endoparasites

Endoparasites -other

PARASITES OF ANTARCTIC VERTEBRATES AND INVERTEBRATES ...Animal Taxonomy, Antarctic Ocean, Collections, Ectoparasites, ...5.0658

COMPARATIVE BIOCHEMICAL AND MORPHOLOGICAL CHARACTERISTICS OF MARINE FUNGI FROM SHELLFISH ...Fungal Culture, Histochemistry - Cytochem, Histology and Cytology, Marine Fungi (non-specific), Plant Taxonomy, ...5.0791

BIOLOGICAL ACTIVITIES OF MARINE FUNGI ...Host-parasite Interactions, Invertebrate Pathology, Marine Fungi (non-specific), Oysters, Pathological Physiology, Plant Developmental Biology, ...5.0699

Helminths

AMINO ACID & PROTEIN METABOLISM IN SCHISTOSOMES ...Amino Acids -non-specific, Flukes, Metabolism, Proteins -non-specific, ...5.0621

SYSTEMATICS OF DEEP SEA TREMATODES ...Animal Taxonomy, Organic Evolution, Trematoda -other, Vertical Distribution, ...5.0646

SYSTEMATIC STUDIES OF CERTAIN MARINE PARASITIC WORMS ...Animal Taxonomy, Life History Studies, Red Worms, Eye Works... , Trematoda -other, ...5.0541

PARASITISM IN DEEPSEA FISHES ...Fish -non-specific, Host Specificity, Protozoa, Vertical Distribution, ...5.0243

EPIDEMIOLOGY OF SALMON POISONING DISEASE ...Epizootic, Infectious Conditions and Dis, Pathology, Salmon & Trout - Non-specific, Water Salinity, ...5.0306

NATURAL HISTORY OF SALMON POISONING RICKETTSIAE ...Flukes, Invertebrates, Neorickettsiae Helmint, Reservoirs, ...5.0842

EPIDEMIOLOGY OF SALMON POISONING DISEASE ...Flukes, Neorickettsiae Helmint, Pathology, Salmon & Trout - Non-specific, Virulence and Pathogenicity, ...5.0307

PARASITES OF PHILIPPINE FISHES ...Animal Distr. (non-specific), Aquatic Ecology, Fish -non-specific, Philippines, ...5.0251

BLOOD PARASITES OF NORTHWEST FISHES ...Blood Plasma and Serum, Codfishes, Hake, Protozoa, Sculpins, Trematoda -other, ...5.0335

Protozoa

PARASITISM IN DEEPSEA FISHES ...Fish -non-specific, Helminths, Host Specificity, Vertical Distribution, ...5.0243

OCCURRENCE OF THE PROTOZOAN PARASITE CERATOMYXA IN ADULT PACIFIC SAIMON AND STEELHEAD TROUT ...Infectious Conditions and Dis, Pathology, Protozoa -other, Rainbow Trout, Steelhead Trout, Vertebrate Pathology, ...5.0308

ULTRASTRUCTURAL STUDIES OF PARASITIC AND SAPROPHYTIC FUNGI AND PROTOZOA ASSOCIATED WITH MARINE INVERTEBRATES ...Cell Cycle, Electron Microscopy, Host-parasite Interactions, Myxomycetes, ...5.0839

PROTOZOOLOGY ...Animal Taxonomy, Axenic Culture, Histology and Cytology, Invertebrate Nutrition, ...5.0443

PATHOLOGY - EPIZOOTIOLOGY ...Epizootiology, Mortality Rates, Oysters, Pathology, Protozoa -other, ...5.0441

PARASITOLOGY ...Ciliates, Crabs, Oysters, Pathology, Protozoa -other, ...5.0440

BLOOD PARASITES OF NORTHWEST FISHES ...Blood Plasma and Serum, Codfishes, Hake, Helminths, Sculpins, Trematoda -other, ...5.0335

Host Resistance

THERMAL ACCLIMATION PATTERNS IN PARASITES AND HOSTS ...Adaptation, Host Specificity, Life History Studies, Monogenea, Water Temperature-non-specific, ...5.0643

Host Specificity

PARASITISM IN DEEPSEA FISHES ...Fish -non-specific, Helminths, Protozoa, Vertical Distribution, ...5.0243

BIOLOGY, MORPHOLOGY, AND EVOLUTION OF THE DISK-FISHES OR SHARKSUCKERS ...Animal Taxonomy, Ethological, Fish -other, Vertebrate Anatomy, ...5.0250

RELATIONSHIP BETWEEN WATER TEMPERATURE AND SIZE OF PARASITIC COPEPODS ...Collections, Copepods, Size, Temperature, Water Temperature-non-specific, ...5.0390

SYSTEMATICS OF CALIGOID COPEPODS ...Animal Taxonomy, Copepods, Ectoparasites, Nomenclature, Classification, ...5.0392

THERMAL ACCLIMATION PATTERNS IN PARASITES AND HOSTS ...Adaptation, Host Resistance, Life History Studies, Monogenea, Water Temperature-non-specific, ...5.0643

Parasitology -other

ADMINISTRATION OF WHALING ACT, COMMERCIALLY UTILIZED WHALES ...Age, Food Supply, Growth Rate, Mammals, Reproduction Studies (general), ...5.0668

PINK SALMON INVESTIGATIONS - EARLY SEA LIFE OF SALMON ...Alaska, Environmental Physiology, Life History Studies, Water Temperature-non-specific, ...5.0187

Reservoirs

NATURAL HISTORY OF SALMON POISONING RICKETTSIAE ...Flukes, Helminths, Invertebrates, Neorickettsiae Helmint, ...5.0842

Animal Pharmacology

Drug Evaluation

ELASMOBRANCH PHARMACOLOGY ...Mechanism of Action, Neuroeffective, Sharks, ...6.0118

ELASMOBRANCH PHARMACOLOGY ...Fish Repellents, Mechanism of Action, Sharks, ...6.0119

Mechanism of Action

ELASMOBRANCH PHARMACOLOGY ...Drug Evaluation, Neuroeffective, Sharks, ...6.0118

ELASMOBRANCH PHARMACOLOGY ...Drug Evaluation, Fish Repellents, Sharks, ...6.0119

MARINE ANIMAL TOXINS ...Fish Repellents, Sharks, Toxins, ...6.0116

Toxins

CHARACTERIZATION AND MODE OF ACTION OF PROTEIN VENOMS OF MARINE ANIMALS ...Lecithin, Mechanism of Action, Sea Urchins & Other Echinoderm, Toxicology, Venom, ...6.0102

MARINE ANIMAL TOXINS ...Fish Repellents, Mechanism of Action, Sharks, ...6.0116

MARINE TOXINS OF THE TROPICAL PACIFIC ...Algal Metab.(non-specific &ot), Fish -non-specific, Pacific Ocean-general, Polynesia, Toxicology, ...6.0113

Plant Origin

LABORATORY STUDIES OF TOXIC DINOFLAGELLATES ...Algal Culture, Algal Toxins, Gonyaulax, Gulf of Mexico, Gymnodinium, ...5.0837

Toxins -non-specific

BIOCHEMISTRY AND PHYSIOLOGICAL ECOLOGY OF POISONED FISH ...Enzymes -non-specific, Fish -non-specific, Metabolism, Muscle, Pathology, ...5.0305

Toxins -other

HEMATOLOGICAL CHANGES IN F. HETEROCLITUS UPON EXPOSURE TO TOXIC METALS ...Blood Cells, Blood Plasma and Serum, Cadmium, Killifishs - Cyprinodon, Lead, ...5.0325

COMPARATIVE TOXICITIES OF METALS TO ESTUARINE FISHES ...Bioassays, Estuaries, Industrial Wastes, Killifishs - Cyprinodon, Solid Waste, ...6.0184

Animal Resistance to ....

Environment Resistance

TEMPERATURE AND SALINITY TOLERANCE OF THE SAND SHRIMP, CRANGON SEPTEMSPINSOA ...Environmental Physiology, Estuaries, Salinity, Shrimps - Common, Temperature, ...**5.0437**

EVOLUTIONARY DIVERGENCE OF ONUPHID POLYCHAETES ...Comparative Physiology, Environmental Physiology, Invertebrate Nutrition, Lugworms, Marine Segmentedworm, Water Temperature-non-specific, ...**5.0663**

ENDOCRINE REGULATED PROCESSES IN TELEOST FISHES ...Comparative Physiology, Fish -other, Hypophysectomy, Osmoregulation, Pituitary, ...**5.0288**

MOVEMENTS OF FRESHWATER CATFISH IN THE ESTUARIES OF SOUTHWEST LOUISIANA ...Blue Catfish, White Catfish, Estuaries, Louisiana, Migration, Water Salinity, ...**5.0090**

TEMPERATURE TOLERANCE OF MARINE ANIMALS THROUGH BEHAVORIAL RESPONSES ...Behavior, Mortality Rates, Thermal, Water Temperature-non-specific, ...**5.0118**

FISH HOLDING AND LIFE STAGE SENSITIVITY STUDIES ...Contamination - Water, Fish, Fish -non-specific, Great Lakes-general, Maturity & Growth Stages, ...**5.0276**

OPERANT OSMOTIC REGULATION IN A MARINE ANIMAL ...Learning and Retention, Octopus, Squid, Cuttlefish... , Osmoregulation, Water Salinity, ...**5.0664**

Animal Taxonomy

SYSTEMATICS OF THE ANTARCTIC AND SUBANTARCTIC GAMMARIDEAN AMPHIPODA ...Abyssal, Antarctic Ocean, Bathyal, Shrimp - Amphipods, Vertical Distribution, ...**5.0359**

PARASITIC COPEPODA %CRUSTACEA*ROM INVERTEBRATES AND FISHES ...Copepods, Ectoparasites, Indian Ocean-general, Invertebrate Anatomy, ...***5.0451***

DISTRIBUTION AND BIOLOGY OF PACIFIC ZOOPLANKTON ...Pacific Ocean-general, Productivity - Food Chain, Range Or Territorial Distr. , Vertical Distribution, Zooplankton, ...**5.0745**

RESEARCH ON INDO-WEST PACIFIC MARINE MOLLUSKS OF THE FAMILY CONIDAE ...Gastropods -slugs,conch,snails, Indian Ocean-general, Invertebrate Anatomy, Number Or Density, ...**5.0517**

THE PORIFERA OF FANNING ISLAND, CENTRAL PACIFIC ...Dispersion -other, Environmental Effects-geologic, Line Islands, Porifera, ...**5.0539**

CONTINUED STUDIES OF THE SYSTEMATICS AND ZOOGEOGRAPHY OF WESTERN ATLANTIC CAECIDAE ...Atlantic Ocean-general, Derivatives, Gastropods - slugs,conch,snails, Invertebrate Anatomy, Pubilications -other, ...**5.0696**

THE ALPHEID SHRIMP OF AUSTRALIA ...Australia, Collections, Pubilications -other, Shrimps - Common, ...**5.0425**

MONOGRAPH OF THE CEPHALOPODS OF THE NORTH ATLANTIC ...Atlantic Ocean-north, Depth, Nomenclature, Classification, Optical, Pubilications -other, Salinity, Temperature, ...**5.0411**

CYTOLOGICAL CHARACTERISTIC ...Basic Embryology, Porifera, Speciation, Structural Functions, ...**5.0557**

A SYSTEMATIC STUDY OF ENTOCYTHERID OSTRACODS ...Madagascar-malagasy Republic, New Zealand, Pubilications -other, Shrimps - Seed Or Mussel, South America, ...**5.0492**

CHONOTRICH CILIATE PROTOZOANS ...Age, Ciliates, Invertebrate Anatomy, Life History Studies, Range Or Territorial Distr. , ...**5.0742**

TAXONOMY AND ECOLOGY OF NEARSHORE MARINE OSTRACODA ...Biofacies, Class Ostracoda, Ecological, Environmental Ecology, Paleoenvironments, Shrimps - Seed Or Mussel, ...**5.0707**

SYSTEMATIC STUDIES ON HERMIT CRABS AND OTHER DECAPOD CRUSTACEANS ...Atlantic Ocean-south, Crabs, Developmental Physiology, Life History Studies, ...**5.0408**

A COMPARATIVE SYSTEMATIC INVESTIGATION OF MARINE CILIATES IN THE HOLOTRICHOUS PROTOZOAN ORDER HYMENOSTOMATIDA ...Cilia and Flagellae, Ciliates, Comparative Physiology, Invertebrate Anatomy, ...**5.0840**

CYTOTAXONOMIC STUDIES OF TELEOST FISHES ...Abyssal, Blood Cells, Minnows, Sets of Chromosomes, ...**5.0242**

ORGANIZATION OF THE ACADEMYS COLLECTION OF RECENT MARINE, TERRESTRIAL, AND FRESHWATER INVERTEBRATES ...Collections, Invertebrates -non-specific, ...**5.0752**

YEAR-ROUND PROGRAM OF RESEARCH IN MARINE ECOLOGY ...Aquatic Ecology, Marine Biology (non-specific), Plant Ecology (non-specific), Plant Taxonomy, Training Grants, Fellowships, ...**5.0899**

REVISION OF THE CLASSIFICATION AND PHYLOGENY OF THE SUBORDER BALANOMORPHA (CIRRIPEDIA - THORACICA) ...Barnacles, Collections, Handbooks, Nomenclature, Classification, Vertical Distribution, ...**5.0704**

ECOLOGY OF SKELETAL PLANKTON ...Collections, Flagellates, Gastropods -slugs,conch,snails, Paleoenvironments, Temporal Distribution, Vertical Distribution, ...**5.0997**

MARINE VERTEBRATES OF THE CALIFORNIA PENINSULA ...California, Environmental Ecology, Range Or Territorial Distr. , Temperature, ...**5.0554**

RELATIONSHIPS AMONG POPULATIONS OF LIMNORIA TRIPUNCTATA ...Isopods, Population Dynamics, Reproductive System, ...**5.0477**

RESEARCH TRAINING IN MARINE BIOLOGY, PALEONTOLOGY AND SYSTEMATIC ZOOLOGY ...Invertebrates - non-specific, Oceanography-general, Paleontology, Training Grants, Fellowships, ...**11.0003**

THE SYSTEMATICS AND ZOOGEOGRAPHY OF THE BRYOZOAN FAUNA OF THE HAWAIIAN ISLANDS ...Australian, Bryozoa, Collections, Hawaii, Range Or Territorial Distr. , ...**5.0542**

SYSTEMATICS OF DEEP SEA TREMATODES ...Helminths, Organic Evolution, Trematoda -other, Vertical Distribution, ...**5.0646**

CYTOTAXONOMY OF SPECIES OF RELATED PELECYPOD MOLLUSKS ...Clams, Derivatives, Invertebrate Anatomy, Oysters, Selection & Breeding, ...**5.0413**

LARVAL DEVELOPMENT OF SCYLLARIDEAN LOBSTERS ...Developmental Physiology, Environmental Physiology, Invertebrate Nutrition, Laboratory, Lobsters, ...**5.0409**

NORTH AMERICAN POST-OLIGOCENE CYTHERID OSTRACODS ...Invertebrate Anatomy, Life History Studies, Nearctic, Phylogenies, Shrimps - Seed Or Mussel, ...**7.0179**

REPRODUCTIVE RELATIONSHIPS AMONG POPULATIONS OF A MARINE WOOD-BORING ISOPOD ...Invertebrate Anatomy, Isopods, Population Dynamics, Reproductive System, ...**5.0414**

SYSTEMATICS AND DISTRIBUTION OF WORMFISHES (MICRODESMIDAE) ...Bone, Collections, Fish -other, Vertebrate Anatomy, Vertical Distribution, ...**5.0115**

MONOGRAPH OF THE FISHES OF THE ORDER PLECTOGNATHI ...Bone, Comparative Anatomy, Fish -other, Pubilications -other, Vertebrate Anatomy, ...**5.0146**

ASCIDIAN SPECIES ON THE ATLANTIC CONTINENTAL SHELF ...Atlantic Ocean-north, Continental Shelf, Range Or Territorial Distr. , Sea Squirts - Tunicates, Vertical Distribution, ...**5.0609**

SYSTEMATIC STUDIES OF CERTAIN MARINE PARASITIC WORMS ...Helminths, Life History Studies, Red Worms, Eye Works... , Trematoda -other, ...**5.0541**

SYSTEMATIC AND DISTRIBUTIONAL STUDY OF DEEP-SEA ECTOPROCTA (BRYOZOA) ...Adaptation, Bryozoa, Ecological, Vertical Distribution, ...**5.0650**

SYSTEMATIC STUDIES OF SPONGES OF THE JAMAICAN FORE-REEF SLOPE ...Habitat Studies, Invertebrate Anatomy, Jamaica, Porifera, Reefs, ...**5.0558**

FAMILIAL RELATIONSHIPS IN TELEOST FISHES ...Comparative Anatomy, Fish -other, Genetic, Karyotypes, Nomenclature, Classification, ...**5.0148**

SYSTEMATICS OF MARINE SYMBIOTIC CRUSTACEA FROM INVERTEBRATES ...Barnacles, Copepods, Life History Studies, Symbiosis, ...**5.0516**

REVISION OF GENERA AND SUBGENERA OF WATER MITES OF THE WORLD ...Growth, Moulting & Metamorph, Nomenclature, Classification, Pubilications -other, Ticks & Mites, World Wide, ...**5.0627**

GENERAL SYSTEMATIC STUDIES OF THE OCTOCORALLIA OF THE TROPICAL ATLANTIC ...Anthozoa, Tropic, ...**5.0589**

GROWTH LAYERING IN BIVALVED MOLLUSKS - AN AID IN PALEOBIOGEOGRAPHIC INTERPRETATION ...Biological Rhythms, Environmental Physiology, Freshwater Mussels, Scallops, Growth Rate, Invertebrate Physiology, ...**5.0355**

ECOLOGICAL INVESTIGATIONS OF MCMURDO SOUND ZOOPLANKTON ...Antarctica, Migration, Vertical Distribution, Zooplankton, ...5.0756

STUDY OF RADIOLARIA IN SURFACE SEDIMENTS OF THE NORTHEAST PACIFIC OCEAN ...Biogenous, Pacific Ocean-north, Protozoa -other, Vertical Distribution, ...7.0187

STABLE ISOTOPE FRACTIONATION IN ECHINODERM CALCITE ...Biogeochemical Process, Calcite, Carbon, Living Organisms, Marine Organisms, Oxygen, Sea Feathers,sea Lily... , Sea Urchins & Other Echinoderm, ...7.0085

PYCNOGONIDA OF THE ANTARCTIC REGIONS ...Antarctica, Benthic Fauna, Collections, Sea Spiders, ...5.0647

SYSTEMATIC STUDIES OF ANTARCTIC COPEPODS ...Antarctic Ocean, Copepods, Mixing, ...5.0461

COOPERATIVE SYSTEMATICS STUDIES IN ANTARCTIC BIOLOGY ...Antarctica, Cooperative-studies, Equipment Purchase Operation, Invertebrates -non-specific, ...5.0581

POLYCHAETES AND ECHINODERMS IN THE LABRADOR SEA ...Brittle Stars, Labrador Sea, Lugworms, Marine Segmentedworm, Reproductive System, Starfishes, ...5.0603

SYSTEMATICS OF ANTARCTIC HYMENOSTOMATIDA (PROTOZOA) ...Antarctica, Aquatic Ecology, Ciliates, Habitat Studies, ...5.0815

BIOLOGY OF THE ANTARCTIC BRACHIOPOD FAUNA ...Museum, Range Or Territorial Distr. , ...5.0454

PARASITES OF ANTARCTIC VERTEBRATES AND INVERTEBRATES ...Antarctic Ocean, Collections, Ectoparasites, Endoparasites -other, ...5.0658

SYSTEMATICS AND ZOOGEOGRAPHY OF ANTARCTIC CEPHALOPODS ...Antarctic Ocean, Australian, Octopus, Squid, Cuttlefish... , Pubilications -other, ...5.0412

DRIFT-STATION BIOLOGY ...Alaska, Arctic Ocean, Oceanic Fronts, Productivity - Food Chain, Sea Ice, ...5.0743

SYSTEMATICS, BIOLOGY, AND HYDROGRAPHIC RELATIONS OF SOME SPECIES OF CALANUS (CRUSTACEA, COPEPODA) ...Copepods, Invertebrate Anatomy, Oceanic Fronts, Vertical Distribution, ...5.0367

TAXONOMY AND DISTRIBUTION OF CLUPEOIDS AND REVISION OF THE GENUS ILISHA OF THE FAMILY CLUPEIDAE ...Alewife,menhaden,shad,herring, Handbooks, Indian Ocean-general, Nomenclature, Classification, Range Or Territorial Distr. , ...5.0088

ECOLOGICAL STUDIES OF ROCKY SUBTIDAL AREAS ...Habitat Studies, Marine Plants, Plant Taxonomy, ...5.0865

FISH POPULATION OFF THE ISLAND OF TUTUILA, AMERICAN SAMOA ...American Samoa, Commercial Fishing, Fish -non-specific, Fishing Gear, Number Or Density, ...5.0032

TAXONOMY AND ECOLOGY OF INSHORE MARINE MICROBIOTA ...Algae- General, Aquatic Ecology, Plant Taxonomy, Protozoa -other, Range Or Territorial Distr. , ...5.0768

SYSTEMATICS, ZOOGEOGRAPHY, AND ECOLOGY OF ELASMOBRANCHS OF THE WESTERN ATLANTIC OCEAN ...Aquatic Ecology, Atlantic Ocean-general, Chondrichthyes -other, Nearctic, ...5.0132

REFERENCE COLLECTION OF GULF MARINE ANIMALS ...Collections, Gulf of Mexico, Invertebrates -non-specific, Vertebrates -non-specific, ...5.0657

SYSTEMATICS MORPHOLOGY AND ECOLOGY OF THE GENUS ERVILIA (MOLLUSCA: PELECYPODA) IN THE WESTERN ATLANTIC ...Atlantic Ocean-general, Ecology (animal), Freshwater Mussels, Scallops, Invertebrate Anatomy, ...5.0458

THE EPICARIDEA OF THE EASTERN PACIFIC ...Isopods, Pacific Ocean-east, ...5.0353

OREGON FISHES - THEIR CLASSIFICATIONS, DISTRIBUTIONS AND LIFE HISTORIES ...Fresh Water, Life History Studies, Oregon, Vertical Distribution, ...5.0137

OREGON FISHES - THEIR CLASSIFICATION, DISTRIBUTION AND BIOLOGY ...Fish -non-specific, Fresh Water, Oregon, Vertical Distribution, ...5.0138

EARLY LIFE OF BOREAL FOOD FISH AND SHELLFISH ...Fish -non-specific, Life History Studies, Mollusks -non-specific & Other, Mortality Rates, ...5.0139

ANALYSIS OF SALMONID SCALES ...Age, Columbia River, Growth Rate, Rainbow Trout, Steelhead Trout, Salmon - coho,chinook,sockeye.., Scales, ...5.0315

BENTHIC MARINE FAUNA OF THE UPPER SHELF OFF VIRGINIA ...Benthic Fauna, Benthonic-bottom, Continental Shelf, Organism Sampling Devices, Virginia, ...5.0660

SYSTEMATICS AND ZOOGEOGRAPHY OF THE BLENNIOID FISHES ...Bone, Fish -other, Nomenclature, Classification, World Wide, ...5.0051

THE TAXONOMY AND ZOOGEOGRAPHY OF THE POLYCHAETOUS ANNELIDS OF THE GULF OF MEXICO AND THE CARIBBEAN SEA ...Caribbean Sea, Gulf of Mexico, Lugworms, Marine Segmentedworm, Neotropical, ...5.0569

SYSTEMATIC REVISION OF THE FAMILY PERIPLOMATIDAE ...Freshwater Mussels, Scallops, Nomenclature, Classification, ...5.0401

THE TAXONOMY AND ZOOGEOGRAPHY OF THE MAGELONIDAE OF THE WORLD ...Collections, Lugworms, Marine Segmentedworm, Nomenclature, Classification, World Wide, ...5.0570

A SYSTEMATIC REVISION OF THE HOLOTHURIAN FAMILY PSOLIDAE - ECHINODERMATA - HOLOTHUROIDEA ...Classification - Taxonomy, Comparative Anatomy, Modern Organisms, Nomenclature, Classification, Sea Cucumber, ...5.0572

MARINE POLYCHAETE WORMS OF THE NEW ENGLAND REGION (GULF OF ST. LAWRENCE TO CHESAPEAKE BAY) ...Lugworms, Marine Segmentedworm, Nomenclature, Classification, Northeast, Vertical Distribution, ...5.0574

MARINE POLYCHAETE WORMS OFF THE COLUMBIA RIVER, OREGON ...Collections, Lugworms, Marine Segmentedworm, Marine Biology, ...5.0575

SYSTEMATICS AND BIOLOGY OF EPIPELAGIC AND BATHYPELAGIC FISHES ...Atlantic Ocean-north, Fish -other, Indian Ocean-general, Vertebrate Anatomy, Vertical Distribution, ...5.0049

MARINE NEMATODES OF THE CAPE COD AREA ...Collections, Habitat Studies, Nematoda -other, Northeast, ...5.0566

A BIBLIOGRAPHY OF THE MARINE MOLLUSKS OF THE INDO-PACIFIC REGION ...Asia, Bibliography, Computer Methods -general, Mollusks -non-specific & Other, ...5.0398

HYPERIID AMPHIPODS FROM THE GULF OF GUINEA ...Collections, Guinea, Oceanography-general, Shrimp - Amphipods, Vertical Distribution, ...5.0387

SYSTEMATICS AND ECOLOGY OF MARINE BIRDS ...Handbooks, Range Or Territorial Distr. , Shorebirds-gulls,terns,skimmer, World Wide, ...5.0582

BIOLOGY, MORPHOLOGY, AND EVOLUTION OF THE DISK-FISHES OR SHARKSUCKERS ...Ethological, Fish -other, Host Specificity, Vertebrate Anatomy, ...5.0250

COPEPODS PARASITIC ON SHARKS OF THE WEST COAST OF FLORIDA ...Copepods, Ectoparasites, Florida, Sharks, ...5.0391

SYSTEMATICS OF CALIGOID COPEPODS ...Copepods, Ectoparasites, Host Specificity, Nomenclature, Classification, ...5.0392

CANADIAN ARCTIC AND SUBARCTIC POLYCHAETES COLLECTED BY E. H. GRAINGER ...Collections, Lugworms, Marine Segmentedworm, Polar, Sub - Polar, ...5.0576

OSTRACODA OF THE INDIAN OCEAN ...Biogenous, Indian Ocean-general, Quaternary Period, Shrimps - Seed Or Mussel, ...5.0385

SYSTEMATICS OF ANTARCTIC SIPUNCULIDS AND ECHIURIDS COLLECTED BY THE ELTANIN EXPEDITION ...Antarctica, Collections, Expeditions, Invertebrates -non-specific, ...5.0578

REPRODUCTIVE BIOLOGY, DEVELOPMENT, AND SYSTEMATICS OF THE SIPUNCULIDS OF THE CARIBBEAN ...Caribbean Sea, Developmental Physiology, Invertebrates -non-specific, Range Or Territorial Distr. , Reproductive System, ...5.0579

SYSTEMATIC STUDIES ON MOLLUSKS FROM WALTERS SHOALS, INDIAN OCEAN ...Collections, Ethiopian, Indian Ocean-general, Mollusks -non-specific & Other, ...5.0402

SYSTEMATICS AND MORPHOLOGY OF THE SIPUNCULID LARVAE OF THE INDIAN OCEAN ...Developmental Physiology, Indian Ocean-general, Invertebrate Anatomy, Invertebrates -non-specific, ...5.0765

STOMATOPOD CRUSTACEA FROM THE WESTERN ATLANTIC ...Atlantic Ocean-general, Shrimps - Mantis... , ...5.0395

THE SYSTEMATICS AND DISTRIBUTION OF THE WORLDWIDE SQUID FAMILY BATHYTEUTHIDAE ...Life History Studies, Number Or Density, Octopus, Squid, Cuttlefish... , World Wide, ...5.0400

ABYSSAL AND BATHYAL SYNOPIIDAE OF WORLD ...Abyssal, Bathyal, Crustacea -non-specific, Vertical Distribution, World Wide, ...5.0384

SYSTEMATIC STUDY OF MYODOCOPID OSTRACODS OF THE INDIAN OCEAN ...Collections, Expeditions, Indian Ocean-general, Shrimps - Seed Or Mussel, ...5.0394

NEPHROPID LOBSTERS OF THE WESTERN ATLANTIC ...Atlantic Ocean-north, Collections, Lobsters, ...5.0396

STOMATOPOD CRUSTACEA OF THE EASTERN PACIFIC REGION ...Atlantic Ocean-general, Pacific Ocean-east, Shrimps - Mantis... , ...5.0397

STUDIES OF FISH FAMILIES ARIIDAE AND ASPREDINIDAE ...Fish -other, Interbiotic Relat.(non-specif), Neotropical, Tropic, ...5.0052

BIOLOGICAL FALSE TARGETS AND RELATED ACOUSTIC CHARACTERISTICS ...Behavioral Ecology, Fish -non-specific, Sound Production, ...1.0041

HEMOGLOBIN VARIATIONS AS INDICATORS OF BLUEFISH RACES ...Bluefish, Hemoglobin, Polymorphism, Reproduction Studies (general), ...5.0320

TAXONOMIC STUDIES ...Fish -other, Nomenclature, Classification, Pacific Ocean-east, ...5.0034

1965 SALT-WATER ANGLING SURVEY ...Censusing, Fish - non-specific, Fishing, ...9.0011

RACIAL STUDIES OF HERRING ...Alewife,menhaden,shad,herring, Atlantic Ocean-north, Biochemical Analysis, Blood Typing Studies, Management -other, ...5.0265

POPULATION STUDIES ...Alewife,menhaden,shad,herring, Animal Distr. (non-specific), Environmental Ecology, Population Dynamics, ...5.0130

MARINE BIOLOGICAL INVESTIGATIONS - TAXONOMIC COLLECTION OF THE FRESH AND SALTWATER FISHES OF ALASKA ...Alaska, Collections, Fish -non-specific, Fresh Water, ...5.0008

STUDIES ON OPHIDIOID FISHES ...Abyssal, Benthic Fauna, Fish -other, Vertebrate Anatomy, Vertical Distribution, ...5.0054

TAXONOMIC REVISION OF BATHYLAGIDAE ...Deepsea Smelts, Tables, Compilations, Catalogs, Temperate, Tropic, ...5.0055

STUDIES ON ANACANTHINE FISHES ...Atlantic Ocean-north, Continental Shelf, Fish -other, Pubilications -other, ...5.0048

SYSTEMATIC STUDIES ON THE FAMILY SCOMBRIDAE ...Indian Ocean-general, Nomenclature, Classification, Tuna, Mackerel, Albacore... , Vertebrate Anatomy, ...5.0056

INVESTIGATE SYSTEMATICS AND ECOLOGY OF TUNA LARVAE AND JUVENILES ...Artifical Insemination, Maturity & Growth Stages, Spawning & Nesting Sites, Tuna, Mackerel, Albacore... , ...5.0079

SYSTEMATIC STUDIES OF FISHES ...Developmental Physiology, Fish -non-specific, Life History Studies, Vertebrate Anatomy, ...5.0059

IDENTIFICATION AND DESCRIPTION OF FISH LARVAE ...Atlantic Ocean-north, Fish -non-specific, Life History Studies, Southern, ...5.0074

IDENTIFICATION OF SOCKEYE SALMON STOCKS BY BONE MINERALS ...Bone, Chemical Analysis, Pacific Ocean-general, Salmon -coho,chinook,sockeye.., ...5.0333

GULF OF ALASKA SOCKEYE SALMON SCALES, PROTOCOL AREA SOCKEYE SALMON SCALES, AND GULF OF ALASKA PINK SALMON SCALES ...Gulf of Alaska, Life History Studies, Salmon -coho,chinook,sockeye.., Scales, ...5.0334

DESCRIPTIONS OF NEW SHARKS ...Collections, Nomenclature, Classification, Publications -other, Sharks, ...5.0057

A REVISION OF THE CAT SHARKS, SCYLIORHINIDAE ...Nomenclature, Classification, Sharks, Vertebrate Anatomy, ...5.0058

EASTERN PACIFIC SHRIMPS OF THE GENUS PENAEUS ...Life History Studies, Pacific Ocean-general, Range Or Territorial Distr. Shrimps - Common, Vertical Distribution, ...5.0403

BENTHIC PENAEID SHRIMPS (OTHER THAN PENAEUS) FROM THE WESTERN ATLANTIC ...Atlantic Ocean-general, Collections, Continental Shelf, Shrimps - Common, Vertical Distribution, ...5.0404

TAXONOMY AND BIOLOGY OF CLUPEOID FISHES ...Alewife,menhaden,shad,herring, Anchovies, Atlantic Ocean-general, Handbooks, ...5.0060

SYSTEMATICS OF CARANGID FISHES ...Collections, Handbooks, Maturity & Growth Stages, Pompanos, Scads, Jacks, Species, Comparison of , ...5.0061

ECOLOGY AND TAXONOMY OF TROPICAL ATLANTIC SCOMBRID EGGS AND LARVAE ...Animal Distr. (non-specific), Basic Embryology, Food Supply, Life History Studies, Tuna, Mackerel, Albacore... , ...5.0772

PROTOZOOLOGY ...Axenic Culture, Histology and Cytology, Invertebrate Nutrition, Protozoa, ...5.0443

ENZYME STRUCTURE AND ITS RELATION TO TAXONOMY ...Conformational Studies, Echinodermata -other, Enzymes -non-specific, Species, ...5.0654

LARVAL DEVELOPMENT OF DECAPOD CRUSTACEA ...Basic Embryology, Bibliography, Crabs, Decapoda - Non-specific, Lobsters, ...5.0410

Annelids

Earthworms

CHEMISTRY AND ENZYMOLOGY OF BIOLUMINESCENCE ...Anthozoa, Bioluminescence, Kinetics -other, Luminous Bacteria, Species, ...5.0962

RESEARCH ON THE MACROBENTHOS OF THE GREAT LAKES ...Aquatic Ecology, Benthic Fauna, Food Supply, Great Lakes-general, Water Quality-general, ...5.0626

Lugworms, Marine Segmentedworm

WATER AND SALT REGULATION IN NEREID POLYCHAETES ...Active Transport, Comparative Physiology, Osmoregulation, Salt, ...5.0648

EVOLUTIONARY DIVERGENCE OF DEEP WATER MARINE ANNELIDS ...Comparative Physiology, Digestive System, Environmental Physiology, Vertical Distribution, ...5.0662

ENVIRONMENTAL SIGNIFICANCE OF SABELLARIID REEFS ...Biology, Habitat Studies, Reefs, ...5.0592

EVOLUTIONARY DIVERGENCE OF ONUPHID POLYCHAETES ...Comparative Physiology, Environment Resistance, Environmental Physiology, Invertebrate Nutrition, Water Temperature-non-specific, ...5.0663

NUCLEIC ACID AND PROTEIN SYNTHESIS DURING OOGENESIS ...Autoradiography, Basic Embryology, Gastropods -slugs,conch,snails, Gene Action, Reproductive System, ...5.1024

DEEP WATER BENTHIC POLYCHAETES ...Benthic Fauna, Biology, Photography, Vertical Distribution, ...5.0540

LIFE HISTORY AND DEVELOPMENT OF POLYCHAETOUS ANNELID LARVAE ...Behavior, Developmental Physiology, Life History Studies, Reproductive System, Whole Body Culture & Rearing, ...5.0604

POLYCHAETES AND ECHINODERMS IN THE LABRADOR SEA ...Animal Taxonomy, Brittle Stars, Labrador Sea, Reproductive System, Starfishes, ...5.0603

ECOLOGY OF SABELLARIID REEFS IN DELAWARE BAY ...Aquatic Ecology, Delaware Bay, Environmental Ecology, Productivity - Food Chain, Vertical Distribution, ...5.0871

STUDY OF LIFE HISTORY AND ECOLOGY OF SERPULIDAE IN TEXAS COASTAL WATERS ...Gulf of Mexico, Life History Studies, Texas, ...5.0656

CILIA DIFFERENTIATION IN MARINE EMBRYOS ...Basic Embryology, Cilia and Flagella, Sea Urchins & Other Echinoderm, ...5.0617

THE TAXONOMY AND ZOOGEOGRAPHY OF THE POLYCHAETOUS ANNELIDS OF THE GULF OF MEXICO AND THE CARIBBEAN SEA ...Animal Taxonomy, Caribbean Sea, Gulf of Mexico, Neotropical, ...5.0569

THE TAXONOMY AND ZOOGEOGRAPHY OF THE MAGELONIDAE OF THE WORLD ...Animal Taxonomy, Collections, Nomenclature, Classification, World Wide, ...5.0570

MARINE POLYCHAETE WORMS OF THE NEW ENGLAND REGION (GULF OF ST. LAWRENCE TO CHESAPEAKE BAY) ...Animal Taxonomy, Nomenclature, Classification, Northeast, Vertical Distribution, ...5.0574

MARINE POLYCHAETE WORMS OFF THE COLUMBIA RIVER, OREGON ...Animal Taxonomy, Collections, Marine Biology, ...5.0575

CANADIAN ARCTIC AND SUBARCTIC POLYCHAETES COLLECTED BY E. H. GRAINGER ...Animal Taxonomy, Collections, Polar, Sub - Polar, ...5.0576

PLANKTON AND BENTHOS COMMUNITIES OF THE GREAT LAKES ...Aquatic Ecology, Benthic Organisms (non-specif), Gastropods -slugs,conch,snails, Lake Erie, Plankton (non-specific), ...**5.0801**

Antarctic Ocean

C-14 UPTAKE, LIMITING FACTORS AND EXCRETION PRODUCTS OF ANTARCTIC PHYTOPLANKTON ...Carbon, Phytoplankton, Primary Productivity, Secretions and Products, ...**5.0813**

SYSTEMATICS OF THE ANTARCTIC AND SUBANTARCTIC GAMMARIDEAN AMPHIPODA ...Abyssal, Animal Taxonomy, Bathyal, Shrimp - Amphipods, Vertical Distribution, ...**5.0359**

THE MARINE GEOLOGY OF THE SOUTHERN OCEAN ...Chemistry, Coring and Dredging, Distribution, Mineralogy, Petrology, ...**7.0067**

MARINE HYDRODYNAMICS ...Circulation-general, Laboratory Analysis, Model Studies, Waves, Waves-internal, ...**8.0196**

LIPID COMPOSITION OF ANTARCTIC MARINE ORGANISMS AND SEA WATER ...Fish -non-specific, Gulf of Mexico, Lipids, Low Temp. -but Above 32f, Phytoplankton, Productivity - Food Chain, Zooplankton, ...**5.1031**

MARINE GEOLOGY OF THE SUB-ANTARCTIC PACIFIC REGION ...Core Analysis, Diagenesis, Distribution, Origin, Petrology, Sedimentary History, ...**7.0049**

A PALEOMAGNETIC STUDY OF TERTIARY AND PLEISTOCENE OCEANIC CORES ...Core Analysis, Field Reversals, Pacific Ocean-north, Paleomagnetism, Quaternary Period, Tertiary Period, ...**7.0166**

EXCHANGE METEOROLOGIST WITH JAPANESE ANTARCTIC RESEARCH EXPEDITION ...Air-sea Boundary-general, General Synoptic Observations, Mixing, Radiosonde, Sea Ice, ...**3.0013**

ANTARCTIC PHYSICAL OCEANOGRAPHY ...Currents-ocean, Depth, Photography, Salinity, Temperature, ...**4.0133**

SYSTEMATIC STUDIES OF ANTARCTIC COPEPODS ...Animal Taxonomy, Copepods, Mixing, ...**5.0461**

HEAVY METAL GEOCHEMISTRY OF ANTARCTIC SEA WATER AND MARINE SEDIMENTS ...Chemistry, Circulation-general, Sedimentation, Water Analysis-general, ...**1.0086**

DEPOSITIONAL PROCESSES MARGINAL TO LARGE ANTARCTIC ICE SHELVES ...Core Analysis, Deposits, Environment, Sedimentary History, Sedimentation, ...**7.0198**

METABOLISM OF COMPLETE WATER COLUMNS ...Autotrophic, Energy Budgets, Metabolism, Respiration, ...**5.0967**

PARASITES OF ANTARCTIC VERTEBRATES AND INVERTEBRATES ...Animal Taxonomy, Collections, Ectoparasites, Endoparasites -other, ...**5.0658**

GEOPHYSICAL STUDIES FROM ELTANIN IN 1968 ...Gravity Surveys, Paleomagnetism, Sea Floor Spreading, Seismic Reflection, Textures-structures, ...**7.0133**

SYSTEMATICS AND ZOOGEOGRAPHY OF ANTARCTIC CEPHALOPODS ...Animal Taxonomy, Australian, Octopus, Squid, Cuttlefish... , Pubilications -other, ...**5.0412**

PALEONTOLOGY OF LATE CENOZIC ANTARCTIC RADIOLARIA AND DIATOMS ...Antarctica, Class Algae, Correlation, Ocean Basins, Order Radiolaria, Paleomagnetism, Paleontology, Rate of Deposition, ...**7.0185**

STRATIGRAPHY AND PALEOECOLOGY OF FOSSIL SILICOFLAGELLATES FROM ANTARTIC DEEP-SEA CORES ...Core Analysis, Correlation, Field Reversals, Fossil Zones, Paleontology, Paleotemperature, Phylum Protozoa, ...**7.0169**

Ross Sea

ANATOMICAL INVESTIGATIONS OF THE LOBODONTINAE ...Collections, Seals, Vertebrate Anatomy, ...**5.0614**

Weddell Sea

ZONATION OF THE WEDDELL SEA BENTHOS ...Benthic Organisms (non-specif), Environmental Ecology, Marine Biology (non-specific), Temperature, ...**5.0868**

BIOLOGICAL PRODUCTIVITY INVESTIGATIONS OF THE WATERS SURROUNDING ANTARCTICA ...Optical, Organics, Phytoplankton, Primary Productivity, Standing Crops, ...**5.1030**

FORMATION OF ANTARCTIC BOTTOM WATERS ...Buoys, Hydrodynamics, Oceanic Fronts, Salinity, Temperature, ...**1.0152**

WATER MASSES, CURRENTS AND ORIGIN OF THE ATLANTIC BOTTOM WATER IN THE WEDDEL SEA, ANTARCTICA ...Currents-bottom, Depth, Oceanic Fronts, Salinity, Sampling, Temperature, ...**4.0134**

INTERNATIONAL WEDDELL SEA OCEANOGRAPHIC EXPEDITION ...Organics, Population Dynamics, Primary Productivity, Productivity - Food Chain, Seals, ...**4.0121**

Antarctica

ECOLOGICAL INVESTIGATIONS OF MCMURDO SOUND ZOOPLANKTON ...Animal Taxonomy, Migration, Vertical Distribution, Zooplankton, ...**5.0756**

RESEARCH VESSEL U.S.N.S ELTANIN ...Equipment Purchase Operation, Geophysics-general, Scientific-service-support, Special Mission Ships, Teaching and Research, ...**12.0036**

THE EFFECTS OF SEAL AND FISH PREDATION ON CERTAIN ANTARCTIC BENTHIC COMMUNITIES ...Benthic Organisms (non-specif), Biology, Fish -non-specific, Predation, Productivity - Food Chain, Seals, ...**5.1039**

THERMALMETABOLIC RELATIONSHIPS OF STENOTHERMAL FISHES ...Environmental Physiology, Fish -non-specific, Proprioceptors, Thermonegulation, Water Pressure, Water Temperature-non-specific, ...**5.0312**

PYCNOGONIDA OF THE ANTARCTIC REGIONS ...Animal Taxonomy, Benthic Fauna, Collections, Sea Spiders, ...**5.0647**

DISTRIBUTION OF ANTARCTIC MARINE FUNGI ...Marine Fungi (non-specific), Phycomycetes, Plant Taxonomy, Range Or Territorial Distr. , Ships and Cruises, Vertical Distribution, ...**5.0694**

POPULATION DYNAMICS OF ANTARCTIC SEALS ...Aerial Photography, Migration, Population Dynamics, Seals, ...**5.0634**

GEOMICROBIOLOGICAL WEATHERING PHENOMENA OFF ANVERS ISLAND ...Habitat Studies, Identification, Marine Bacteria, Petrography, Weathering, ...**7.0232**

COOPERATIVE SYSTEMATICS STUDIES IN ANTARCTIC BIOLOGY ...Animal Taxonomy, Cooperative-studies, Equipment Purchase Operation, Invertebrates -non-specific, ...**5.0581**

SYSTEMATICS OF ANTARCTIC HYMENOSTOMATIDA (PROTOZOA) ...Animal Taxonomy, Aquatic Ecology, Ciliates, Habitat Studies, ...**5.0815**

ATMOSPHERIC-OCEANIC-GLACIOLOGIC INTERACTIONS IN THE ANTARCTIC ...Boundary Layer Studies, Heat Budget, Heat Exchange, ...**3.0009**

DEEP DIVING ANTARCTIC BIRDS AND MAMMALS ...Adaptation, Locomotion -animal, Penguins, Seals, Water Pressure, ...**5.0555**

PARTICIPATION IN USARP EXPEDITIONS ...Data Acquisition, Data Analysis - General, Marine Biology, Ships and Cruises, Teaching and Research, ...**12.0012**

MAGNETIC PROPERTIES OF ANTARCTIC MARINE SEDIMENTS AND ROCKS ...Core Analysis, Extinction, Field Reversals, Rock & Mineral Magnetics, ...**7.0233**

CONTRACT FOR-PROCESSING OF USARP ROCK SAMPLES ...Classifications, Collections, Coring and Dredging, Petrology, Sampling, Ships and Cruises, Thin Sections, ...**7.0060**

OPERATION OF THE R/V HERO AND PALMER STATION SUPPORT LABORATORY ...Facilities, Marine Biology (non-specific), Ships and Cruises, ...**12.0023**

PALEONTOLOGY OF LATE CENOZIC ANTARCTIC RADIOLARIA AND DIATOMS ...Antarctic Ocean, Class Algae, Correlation, Ocean Basins, Order Radiolaria, Paleomagnetism, Paleontology, Rate of Deposition, ...**7.0185**

GRAVITY AND EARTH TIDES ...Earth Interior, Earth Tides, General Gravimeters, Propagation, Tides, ...**2.0077**

SYSTEMATICS OF ANTARCTIC SIPUNCULIDS AND ECHIURIDS COLLECTED BY THE ELTANIN EXPEDITION ...Animal Taxonomy, Collections, Expeditions, Invertebrates - non-specific, ...**5.0578**

Anthozoa

CHEMISTRY AND ENZYMOLOGY OF BIOLUMINESCENCE ...Bioluminescence, Earthworms, Kinetics -other, Luminous Bacteria, Species, ...**5.0962**

ECOLOGY OF THE PORITES FURCATA REEF-FLAT COMMUNITY ...Panama, Productivity - Food Chain, Puerto Rico, Reefs, ...**5.0867**

GENERAL SYSTEMATIC STUDIES OF THE OCTOCORALLIA OF THE TROPICAL ATLANTIC ...Animal Taxonomy, Tropic, ...**5.0589**

CARBON-14 AGE PROFILE OF A HAWAIIAN REEF ...Carbon-14, Coring and Dredging, Growth Rate, Hawaii, Reefs, Sea Level Variations, ...**7.0051**

CORAL ATOLL ECOLOGY ...Atolls, Bibliography, Data Analysis - General, Productivity - Food Chain, ...**5.0872**

SYMBIOSIS OF TROPICAL ZOANTHIDEA AND ZOOXANTHELLAE ...Messenger RNA , Metabolism, Symbiosis, Tropic, Zooxanthella, ...**5.0642**

FORMATION AND UTILIZATION OF TERPENES ...Biosynthesis, Enzyme-substrate, Symbiosis, Terpenes, Zooxanthella, ...**5.0957**

NATURAL COMPOUNDS WITH CARBON-PHOSPHORUS BONDS ...Bond Type, Decomposition-other, Natural Occurring, Phosphorous, ...**5.1013**

Antibiotics

NEW DRUGS FROM THE SEA, ESPECIALLY ANTIBIOTICS ...Caribbean Sea, Marine Plants, Pacific Ocean-general, ...**6.0123**

Antimetabolites -non-specific

GROWTH AND TOXICOGENESIS OF C. BOTULINUM IN FISHERY PRODUCTS ...Bacterial Exotoxins, Clostridium Botulinum, Fish -non-specific, Growth (non-specific & Ot.), Medical Studies, Microbiological, ...**6.0043**

Appalachian Highlands

New England Province

ESTUARINE SEDIMENTATION PROCESSES ...Estuaries, General Deposition, Intertidal Areas, Morphology-general, Tidal Streams, Tides, ...**7.0244**

A STUDY OF THE ECOLOGY OF THE MICROFAUNA LIVING BETWEEN INTERTIDAL MARINE SEDIMENTS ...Beach, Copepods, Crustacea -non-specific, Intertidal Areas, Salinity, ...**5.0793**

TROPHIC RELATIONSHIPS IN SHOAL PENTHIC ENVIRONMENTS ...Benthic Flora, Biology, Estuaries, Habitat Studies, ...**5.1027**

Applied Electronics

DIGITIZING SYSTEM FOR OCEANOGRAPHIC DATA ...Analog-digital Converters, Bathymetry, Digital Computers, Instrumental Services, Seismic Studies, Spectral Analysis, ...**4.0039**

STUDIES OF EARTHQUAKES IN THE CAPE MENDOCINE AREA ...Data Transmission Systems, Earthquake Location, Earthquakes, Seismic Studies, Telemetry-other, ...**7.0088**

OCEAN SYSTEM TELEMETRY STUDY ...Buoys, Data Acquisition, Data Transmission Systems, Moorings, Telemetry-other, ...**4.0002**

OCEAN ENGINEERING STUDIES ...Data Acquisition, Data Processing Services, Engineering Studies-general, Instrumental Services, Laboratory Analysis, Sonar, ...**8.0052**

ARCTIC SEISMIC TRANSDUCER EVALUATION ...Arctic, Evaluation Other, Ice Acoustics, Propagation, Transducers, ...**8.0118**

ARCTIC ACOUSTIC RESEARCH ...Arctic, Ice Acoustics, Noise, Transmission, ...**1.0001**

Biological Sciences

BIOLOGICAL INSTRUMENTATION ...Behavioral Ecology, Instrumental Services, Instrumentation-general, Navigation Systems-other, ...**8.0064**

APPLICATION OF BIOTELEMETRY TO THE STUDY OF MARINE VERTEBRATES ...Central Nervous System, Fish -non-specific, Locomotion -animal, Telemeters, Telemetry, ...**5.0637**

Aquaculture & Fish-farming

DEVELOPMENT OF TECHNIQUES FOR THE AQUACULTURE OF POMPANO ...Environmental Physiology, Florida, Maturity & Growth Stages, Pathology, Tuna, Mackerel, Albacore... , ...**8.0007**

SHRIMP PRODUCTION IN LOUISIANA SALT-MARSH IMPOUNDMENTS UNDER EXISTING AND MANAGED CONDITIONS ...Captive Rearing, Lagoons, Louisiana, Shrimps - Common, Water Movement, Currents,, ...**5.0435**

SYSTEMS ENGINEERING AND DEVELOPMENT OF COMMERCIALLY VALUABLE MARINE RESOURCES IN THE DELAWARE AREA ...Commercial Fishing, Delaware, Fish & Shellfish, Oysters, Quality -non-specific, ...**8.0002**

THE STATUS AND POTENTIAL OF AQUACULTURE ...Algal Culture, Fish -non-specific, Food Supply, Survey Studies, ...**8.0003**

OYSTER FATNESS STUDY ...Fats - Lipids & Oils, Food Supply, Growth Rate, Invertebrate Nutrition, Oysters, ...**5.0512**

BIONOMICS OF FISHES AND SHELLFISHES ...Bays, Economics-general, Environmental Ecology, Oregon, Productivity - Food Chain, ...**5.0920**

CONSTRUCTION OF A NEW SERIES OF SMALL REPLICATION PONDS AND RESEARCH ON THE FACTORS LIMITING FISH PRODUCTION IN IMPOUNDED WATERS ...Ponds, Productivity (agricultural), ...**8.0001**

CULTURE OF POMPANO IN BRACKISH WATER PONDS ...Brackish Water, Food Supply, Louisiana, Pompanos, Scads, Jacks, Stocking of Fish & Shellfish, ...**8.0004**

CULTURE OF ATLANTIC CROAKER IN BRACKISH WATER PONDS ...Brackish Water, Captive Rearing, Drums, Management, Ponds, Productivity (agricultural), ...**8.0005**

CULTURE OF RED SWAMP CRAWFISH, PROCAMBARUS CLARKI, IN BRACKISH WATER PONDS ...Aquatic Ecology, Brackish Water, Captive Rearing, Crayfish, ...**5.0432**

CULTURE OF BLUE, CHANNEL, AND WHITE CATFISH IN BRACKISH WATER PONDS ...Blue Catfish, White Catfish, Brackish Water, Captive Rearing, Channel Catfish, Louisiana, ...**8.0006**

THE DEVELOPMENT OF HATCHERY TECHNIQUES TO AID IN THE PRODUCTION OF ECONOMIC MOLLUSKS ...Captive Rearing, Clams, Food Supply, Oysters, Spawning & Nesting Sites, ...**5.0483**

LIFE HISTORY OF CLUPEA HARENGUS PALLASI ...Alewife,menhaden,shad,herring, Artifical Insemination, Life History Studies, Water Salinity, Water Temperature-non-specific, ...**5.0035**

METHODS OF REARING EGGS AND LARVAE TO JUVENILE STAGES ...Captive Rearing, Environmental Physiology, Fish -non-specific, Maturity & Growth Stages, ...**8.0010**

131.116B - LARVAL CULTURE (SHRIMP AQUACULTURE PROGRAM) ...Algal Culture, Captive Rearing, Environmental Physiology, Food Supply, Shrimps - Common, ...**5.0500**

JUVENILE AND ADULT CULTURE (SHRIMP AQUACULTURE PROGRAM) ...Captive Rearing, Growth Rate, Ponds, Shrimps - Common, ...**5.0504**

FOOD AND EXPERIMENTAL ENVIRONMENTS (SHRIMP AQUACULTURE PROGRAM) ...Captive Rearing, Digestive System, Food Supply, Shrimps - Common, Water Environment -other, ...**5.0505**

Aquatic Or Soil-aquatic Cycles

PESTICIDES ...Bioassay , Fish, Persistance of Residues, Pesticides -non-specific, Pollution Effects, ...**5.0881**

PESTICIDE KINETICS ...Degradation, Estuaries, Insecticides - non-specific, Marine Biology (non-specific), Pollutants - Path of , ...**6.0148**

Aquatic Soils

BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SALT MARSH ENVIRONMENT -...Core Analysis, Identification, Marine Bacteria, Salinity, Swamps-marshes, Temperature, Water Level Fluctuation, ...**5.0763**

RELATIONSHIPS BETWEEN PHOSPHATE AND OTHER CHEMICALS AT THE WATERSUBSTRATE INTERFACE IN WESTERN LAKE ERIE ...Chemical, Chemical-general, Lake Erie, Phosphate, Phosphite, Sediments, ...**7.0078**

HYDROGRAPHY, SEDIMENTATION AND CHEMICAL ASPECTS OF THE REEF ENVIRONMENT ...Currents-ocean, Environmental Ecology, Fish -non-specific, Reefs, ...**5.0212**

Aqueducts

SURFACE AND GROUND WATER POTENTIALITIES OF THE MULLICA RIVER BASIN ...Conjunctive Use, Economic Impact, Estuaries, Systems Analysis, Water Quality-general, Water Transfer, ...**9.0014**

Aquifers

HYDROLOGY OF COASTAL AREA IN THE VICINITY OF RICEBORO, GEORGIA ...Artesian Flow, Dispersion -water, Estuaries, Georgia, Saline Water Intrusion, Water Quality-general, ...9.0007

REMOTE SENSING, GULF COASTAL AREA, CENTRAL FLORIDA ...Aircraft, Fresh Water, Saline Water Systems, Temperature, Tides, ...4.0160

Arachnids -spiders,ticks,mites

Horseshoe Or King Crabs

NEUROPHYSIOLOGICAL INVESTIGATIONS OF LIMULUS CENTRAL NERVOUS SYSTEM ...Brain , Cardiovascular, Nervous System, ...5.0469

THE EFFECT OF SOME NEUROTRAMSMITTERS ON THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Brain, Cardiovascular, Nerve Effects, Neuroeffective, ...5.0470

KODIAK KING CRAB ENVIRONMENTAL ZONE SURVEY ...Alaska, Continental Shelf, Environmental Ecology, Reproductive System, ...5.0348

A HISTOCHEMICAL STUDY OF THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Cholinesterase, Histochemistry - Cytochem, Nervous System, Organelle-enzyme Assn, ...5.1000

PHYSIOLOGY OF THE LIMULUS HEART ...Biological Rhythms, Cardiovascular, Heart, Nervous System, ...5.0463

NEUROPHYSIOLOGICAL MECHANISMS IN BEHAVIOR ...Giant Water Bug, Water Strider, Locomotion, Proprioceptors, ...5.0490

BIOCHEMICAL CHARACTERIZATION OF CHOLINESTERASES IN THE BLOOD ANDCENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Blood and Lymph, Cholinesterase, Enzyme-substrate, Nervous System, Reaction Rates, ...5.0468

Sea Spiders

PYCNOGONIDA OF THE ANTARCTIC REGIONS ...Animal Taxonomy, Antarctica, Benthic Fauna, Collections, ...5.0647

Ticks & Mites

REVISION OF GENERA AND SUBGENERA OF WATER MITES OF THE WORLD ...Animal Taxonomy, Growth, Moulting & Metamorph, Nomenclature, Classification, Pubilications - other, World Wide, ...5.0627

Arctic

ARCTIC BIBLIOGRAPHY PROJECT ...Bibliography, Geophysics-general, Meteorological Studies-general, Oceanography-general, ...11.0013

ARCTIC BASIN HEAT FLOW ...Coring and Dredging, Crust, Geothermal Gradient, Heat Flows, Physical Properties, ...7.0105

ARCTIC AIR, SEA AND ICE ...Climatography, Heat and Radiation Transfer, Heat Exchange, Micrometeorology, Sea Ice, Weather Forecasting, ...3.0088

ARCTIC FIELD RESEARCH ...Geology-general, Glaciology-general, Marine Biology, Micrometeorology, ...11.0010

RADIOLARIA IN PACIFIC SEDIMENTS ...Biogenous, Classification - Taxonomy, Order Radiolaria, Pacific Ocean-north, Population - Distribution, ...7.0284

CHEMICAL OCEANOGRAPHY ...Circulation-general, Isotope Tracer-other, Oceanic Fronts, Tracers, Water Analysis-general, ...1.0072

ARCTIC PLANKTON ECOLOGY ...Acoustical, Marine Biology (non-specific), Oceanic Fronts, Plankton (non-specific), Population Dynamics, ...1.0017

BIOLOGICAL OCEANOGRAPHY ...Organics, Phytoplankton, Temporal Distribution, ...5.1038

ARCTIC SEISMIC TRANSDUCER EVALUATION ...Applied Electronics, Evaluation Other, Ice Acoustics, Propagation, Transducers, ...8.0118

ACOUSTIC AMBIENT NOISE ...Acoustical, Liquids, Noise, Spectra, ...1.0053

ARCTIC UNDERSEAS RESEARCH, JOINT USA-CANADIAN HEAT BUDGET STUDY ...Heat and Radiation Transfer, Instrumentation-general, Physical Climatology, Sea Ice, ...3.0071

ARCTIC ACOUSTIC RESEARCH ...Applied Electronics, Ice Acoustics, Noise, Transmission, ...1.0001

ARCTIC SUPPORT ...Remote Sensing-general, Scientific-service-support, Sea Ice, Submerged Ships, ...3.0080

WESTERN ARCTIC OCEANOGRAPHIC INVESTIGATIONS ...Arctic Ocean, Basins, Circulation-general, Mixing, ...2.0014

Arctic Ocean

SATELLITE SEA ICE STUDIES USING HRIR ...Data Analysis - General, Infrared Radiation, Satellites, Sea Ice, Technique Development, ...3.0075

WEATHER PROGRAM - STATION T-3 ...Drift Stations, Energy Exchange Processes, Heat Budget, Patterns, Physical Climatology, Weather Forecasting, ...3.0060

ARCTIC RESEARCH ...Acoustical, Currents-ocean, Geomorphology-topography, Magnetic Studies, Sea Ice, ...4.0049

ARCTIC BIOLOGICAL OCEANOGRAPHY ...Adaptation, Growth and Differentiation, Phytoplankton, Potamogeton, Ruppia, Zostera. , Water - Light Qual. & Quant. , Water Temperature -other, ...5.0853

CLIMATE CHANGE OVER THE POLAR OCEAN ...Heat and Radiation Transfer, Heat Budget, Numerical Analysis-other, Physical Climatology, ...3.0058

DISTRIBUTIONS OF CURRENTS AND PHYSICAL PROPERTIES WITHIN THE ARCTIC OCEAN ...Acoustical, Currents-ocean, Heat and Radiation Transfer, Sea Ice, Temperature, ...4.0051

ARCTIC SUB-ICE STUDY ...Acoustical, Marine Biology, Sea Ice, Submersibles, ...3.0074

ARCTIC RESEARCH LABORATORY ...Acoustical, Alaska, Drift Stations, Seismic Studies, Terrain Analysis, ...12.0003

DRIFT-STATION BIOLOGY ...Alaska, Animal Taxonomy, Oceanic Fronts, Productivity - Food Chain, Sea Ice, ...5.0743

ARCTIC FIELD RESEARCH ...Bibliography, Environmental Effects-geologic, Geophysics-general, Russia, ...11.0011

ARCTIC ADVISORY SERVICE ...Bibliography, Ice Properties-general, Library, Sea Ice, ...11.0012

ARCTIC UNDERSEAS RESEARCH, PHYSICAL AND CHEMICAL PROPERTIES OF SEA ICE ...Environmental Effects-geologic, Ice Properties-general, Model Studies, Sea Ice, ...3.0070

ISOTOPIC OCEANOGRAPHY ...Data Acquisition, Oceans - Sea Water, Radioactivity-general, Sampling, Trace Elements, ...1.0090

PREDICTION OF POLAR ICE BEHAVIOR AND DISTRIBUTION ...Data Acquisition, Forecasting-prediction, Hydrodynamics, Ice-general, Sea Ice, Weather Forecasting, ...3.0078

WESTERN ARCTIC OCEANOGRAPHIC INVESTIGATIONS ...Arctic, Basins, Circulation-general, Mixing, ...2.0014

Baffin Bay

SEDIMENTS IN BAFFIN BAY AND THE EFFECTS OF AN ARCTIC ENVIRONMENT ON MARINE SEDIMENTATION ...Benthonic-bottom, Origin, Physical Properties, Polar, Sedimentation, ...7.0265

ARCTIC EAST OCEANOGRAPHIC PROJECT (OCEANOGRAPHY OF THE BAFFIN BAY REGION) ...Circulation-general, Marine Biology, Polar, Sea Water Chemistry-other, Water Properties-general, ...4.0125

Beaufort Sea

GRAVITY SURVEY ARCTIC OCEAN ...Bathymetry, Continental Shelf, Geodetic Surveys, Gravity Studies, Seismic Studies, Structural Studies, ...7.0154

Chuckchi Sea

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GEOLOGIC HISTORY OF BERMUDA AND ITS RELATIONSHIP TO THE WORLD PLEISTOCENE ...Correlation, Development, Local Stratigraphy, Quaternary Period, Sea Level Changes, ...7.0155

OCEANIC INTERNAL MOTIONS AFFECTING OPERATIONS ...Buoys, Military Aspects, Thermal, Water Motion Recorders, Waves-internal, ...2.0115

LONG-PERIOD WAVES ...Pressure, Sea Level Variations, Statistics-general, Waves, ...2.0085

SHALLOW WATER MEIOBENTHOS OF THE BERMUDA PLATFORM ...Benthic Fauna, Benthonic-bottom, Continental Shelf, ...5.0649

RELIABLE ACOUSTIC PATH ...Acoustical, Attenuation, Ranging, Reverberation, Transmission, ...1.0032

MODERN VERSUS RELICT SEDIMENT PATTERNS ON CONTINENTAL MARGINS ...Canada, Continental Shelf, Distribution, Quaternary Period, Sea Level Changes, ...7.0214

TELEMETRY STUDIES ON MARINE BIRDS ...Albatrosses, Shearwaters... , Mark, Tag Or Capture -other, Pelicans, Cormorants,darters.., Spawning & Nesting Sites, ...5.0531

Bioassays

NEW APPROACHES TO BIOFOULING ASSAY ...Corrosion Prevention-other, Fouling, Marine Biology (non-specific), Paint - General, Powder, ...5.0757

USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS ...Chemical Identification, Marine Biology (non-specific), Plankton (non-specific), Pollution - Effects of , ...6.0183

COMPARATIVE TOXICITIES OF METALS TO ESTUARINE FISHES ...Estuaries, Industrial Wastes, Killifishs - Cyprinodon, Solid Waste, Toxins -other, ...6.0184

USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS ...Estuaries, Phytoplankton, Pollution - Effects of , Pollution Effects, Zooplankton, ...5.0832

DEVELOPMENT OF A METHOD FOR CHRONIC TOXICITY BIOASSAY USING MARINE PLANKTONIC ALGAE ...Algal Culture, Marine Plants, Microbiological Analysis, Monitoring (long Term Studies), Phytoplankton, Technique Development, Toxicology, ...5.0726

PHYSIOLOGY AND ASSAY OF PROLACTIN IN FISH ...Biochemical, Gambusia, Molly, Immunology, Luteotrophic Hormone, Pituitary, ...5.0329

CHEMISTRY OF ALGAL TOXINS ...Algal Toxins, Aphanizomenon, Biochemical Analysis, Gymnodinium, Microbiological Analysis, ...5.0709

Biochemical Analysis

IMMUNOLOGY AND SEROLOGY OF MARINE ANIMALS ...Agglutination Tests, Blood Plasma and Serum, Immunology, Pathology, ...5.0977

RACIAL STUDIES OF HERRING ...Alewife,menhaden,shad,herring, Animal Taxonomy, Atlantic Ocean-north, Blood Typing Studies, Management -other, ...5.0265

RED TIDE TOXICITY ...Algal Toxins, Gas Chromatography, Gymnodinium, Plant Developmental Biology, Pollution Sources-other, ...5.0780

ORGANIC CHEMICAL STUDIES ON ANIMAL AND PLANT TOXIN ...Algal Toxins, Animal Toxins, Medicinal Plants, Plant Alkaloids, Plant Toxins, ...6.0115

CHEMISTRY OF ALGAL TOXINS ...Algal Toxins, Aphanizomenon, Bioassays, Gymnodinium, Microbiological Analysis, ...5.0709

Fats

DEVELOPMENTAL ANALYSIS OF FUNDULUS ...Basic Embryology, Central Nervous System, Killifishs - Cyprinodon, Phospholipids, Transplants, ...5.0316

Hormones

ISOLATION AND FUNCTION OF OVARIAN EXTRACTS CAPABLE OF INDUCING COCYTE SHEDDING AND OCYTE NUCLEAR MATURATION IN STARFISH ...Differentiation Mechanism, Female, Nucleic Acids, Reproductive System, Starfishes, ...5.0620

MARINE ANIMAL USE IN THE STUDY OF HEALTH PROBLEMS ...Hormones - Other, Life History Studies, Metabolism, ...6.0126

NEUROSECRETION AND ENDOCRINE PHYSIOLOGY ...Configuration, Crustacea -non-specific, Diabetogenic, Ns, Endocrine System, Intermedin, ...5.1023

Proteins and Amino Acids

GRANT FOR RESEARCH IN ISOLATION OF MARINE PROTEINS ...Marine Biology (non-specific), Proteins -non-specific, ...5.0998

Biomedical Engineering

Electronic

Sound Level Analyzers

STANDARDS FOR AUDIOMETRY ...Acoustic, Calibration and Calibrators, Standards, Specifications, Transducers, ...8.0127

Telemeters

APPLICATION OF BIOTELEMETRY TO THE STUDY OF MARINE VERTEBRATES ...Biological Sciences, Central Nervous System, Fish -non-specific, Locomotion -animal, Telemetry, ...5.0637

Transducers

BASIC ACOUSTICAL STANDARDS AND MICROPHONE CALIBRATION ...Acoustic, Acoustical, Audio Frequency, Calibration and Calibrators, Standards, Specifications, ...8.0076

STANDARDS FOR AUDIOMETRY ...Acoustic, Calibration and Calibrators, Sound Level Analyzers, Standards, Specifications, ...8.0127

Biophysics & Molec. biology

Elec Prop and Ion

Elect Trans and Redox

PHOTOBIOLOGICAL STUDIES ON MARINE CHRYSOMONADS ...Autotrophic, Coccoliths, Photochemistry, Photosynthetically Active, ...5.0932

RESEARCH ON THE ROLE OF BACTERIA IN THE OCEAN ...Denitrification, Marine Bacteria, Microorganism Enzymes, Nitrogen Bacteria, Respiration, ...5.0783

Energy Conversion

EXCITED STATES MECHANISMS IN PHOTOBIOLOGY ...Bioluminescence, Chemiluminescence, Photochemical-other, Polypeptides, ...4.0162

MECHANISM STUDIES ON BIOLUMENESCENT REACTIONS WITH EMPHASIS ON ENERGY TRANSFER PROBLEMS ...Bioluminescence, Luciferase, Luciferin, ...1.0164

Molecular Interaction

Struct Activity Relation

STUDIES ON THE STRUCTURE OF HEMERYTHRIN ...Biochemical, Comparative Physiology, Configuration, Hemerythrin, Invertebrates -non-specific, ...5.0993

FILAMENTS, MORPHOGENESIS AND CONTRACTION OF MUSCLE ...Contraction and Relaxation, Fibrils and Filaments, Subunits, ...5.0986

MOLECULAR ASPECTS OF CELLULAR DIFFERENTIATION AND DIVISION ...Basic Embryology, Biosynthesis, Cell Cycle, Differentiation Mechanism, Proteins, Replication, Sea Urchins & Other Echinoderm, ...5.0985

STRUCTURE AND REACTIVITY OF PROTEINS AND LIPOPROTEINS ...Configuration, Hemoglobin, Physical State, ...5.0971

Photochemistry

PHOTOBIOLOGICAL STUDIES ON MARINE CHRYSOMONADS ...Autotrophic, Coccoliths, Elect Trans and Redox, Photosynthetically Active, ...5.0932

INTERACTION OF PROTEINS WITH METAL AND HYDROGEN IONS ...Globin -incl. myoglobin, Inhibitors, Metallic Ions, Neurophysin, Ribonuclease, ...5.0999

PHOTOBIOLOGY OF MARINE ANIMALS ...Photoreception, Physical State, Visual, Visual Organs, ...5.0313

Stability

EFFECT OF LIPIDS ON STABILITY OF BIOLOGICAL MEMBRANES ...Cellular Membranes (non-spec.), Coenzyme Q, Electron Microscopy, Tocopherol, Vitamin A, ...5.1007

Structure

Bonding and Binding

RESEARCH STUDIES IN MOLECULAR PHARMACOLOGY ...Anesthetic, Diving and Scuba, Mechanism of Action, Permeability, Thermodynamics, ...6.0100

Composition of Macromolecules

STUDIES OF THE AEROCOCCUS-PEDIOCOCCUS BACTERIA ...Bioenergetics, Classification Or Taxonomy, Detection, Pediococcus, ...5.0817

Configuration

STUDIES ON THE STRUCTURE OF HEMERYTHRIN ...Biochemical, Comparative Physiology, Hemerythrin, Invertebrates -non-specific, ...5.0993

CELL DIVISION, BIOENERGETICS, CHEMISTRY OF MUSCLE ...Bioenergetics, Cell Cycle, Glyoxal, Organic, ...5.0987

STRUCTURE AND REACTIVITY OF PROTEINS AND LIPOPROTEINS ...Hemoglobin, Physical State, ...5.0971

PRIMARY STRUCTURE OF INVERTEBRATE HEMOGLOBINS ...Biochemical, Chitons, Gastropods - slugs,conch,snails, Globin -incl. myoglobin, ...5.0610

NEUROSECRETION AND ENDOCRINE PHYSIOLOGY ...Crustacea -non-specific, Diabetogenic, Ns, Endocrine System, Hormones, Intermedin, ...5.1023

Molec. struct. (gen. & Other)

USEFUL BIOMEDICAL MATERIALS DERIVED FROM THE SEA - AN INTERDISCIPLINARY APPROACH ...Antibody Formation, Bioluminescence, Immunology, ...6.0106

CHEMISTRY AND FUNCTION OF BRAIN PLASMALOGENS ...Chem and Metab, Comparative Physiology, Phospholipids, Plasmalogen, ...5.1003

Physical State

STRUCTURE AND REACTIVITY OF PROTEINS AND LIPOPROTEINS ...Configuration, Hemoglobin, ...5.0971

PHOTOBIOLOGY OF MARINE ANIMALS ...Photochemistry, Photoreception, Visual, Visual Organs, ...5.0313

Subunits

FILAMENTS, MORPHOGENESIS AND CONTRACTION OF MUSCLE ...Contraction and Relaxation, Fibrils and Filaments, ...5.0986

CILIA DIFFERENTIATION IN THE SEA URCHIN EMBRYO ...Basic Embryology, Cilia and Flagella, Differentiation Mechanism, Proteins, Sea Urchins & Other Echinoderm, ...5.0616

Thermodynamics

Kinetics

CIRCADIAN RHYTHM IN PHOTOSYNTHESIS IN THE MARINE ALGAE GONYAULAX AND ACETABULARIA ...Acetabularia, Autotrophic, Biological Rhythms, Control and Regulation, Gonyaulax, ...5.0685

FACTORS INFLUENCING THE INTENSITY OF BIOLUMINESCENCE ...Bioluminescence, Cell. env.(non-specific & Ot.), Marine Biology, Optical, Trace Elements, ...1.0169

Birds

Albatrosses, Shearwaters...

ECOLOGY OF STORM PETRELS ...California, Islands, Mark, Tag Or Capture -other, Spawning & Nesting Sites, Terrestrial Ecology, ...5.0532

THE BIOLOGY OF THE LAYSAN AND BLACK-FOOTED ALBATROSSES ...Age, Animal Distr. (non-specific), Control of Nuisance Species, Mark, Tag Or Capture -other, Spawning & Nesting Sites, ...5.0607

TELEMETRY STUDIES ON MARINE BIRDS ...Bermuda, Mark, Tag Or Capture -other, Pelicans, Cormorants,darters.., Spawning & Nesting Sites, ...5.0531

Anseriformes -other

EVALUATION OF THE ATLANTIC FLYWAY SEA DUCK KILL ...Age, Hunting, Mortality Rates, Sex -non-specific, Species, Comparison of , ...5.0606

Aves -other

MOVEMENTS OF SEABIRDS IN THE HUMBOLDT CURRENT ...Biological Rhythms, Humboldt Or Peru Current, Population Dynamics, Temporal Distribution, ...5.0583

Birds -non-specific

DISTANT GOAL ORIENTATION ...Biological Rhythms, Locomotion -animal, Magnetic Impulses, Mark, Tag Or Capture -other, Orientation, ...4.0109

AVIFAUNAL ECOLOGY OF LIMANTOUR ESTERO ...California, Food Supply, Game Reserves & Preserves, Habitat Studies, ...5.0534

PACIFIC OCEAN BIOLOGICAL SURVEY PROGRAM ...Islands, Meteorological Studies, Pacific Ocean-general, Vertical Distribution, ...5.0568

AUTOMATIC DATA PROCESSING - SEABIRD DISTRIBUTION ...Computer Methods -general, Nomenclature, Classification, Range Or Territorial Distr. , World Wide, ...4.0020

Chickens

STUDIES ON EMBRYONIC CELLS ...Basic Embryology, Reproductive System, Sea Squirts - Tunicates, Suspension Culture, ...5.0945

BIOCHEMICAL BASIS OF SPECIFIC CELL ASSOCIATION ...Adhesion, Basic Embryology, Pacific Ocean-general, Porifera, ...5.0946

Pelicans, Cormorants,darters..

TELEMETRY STUDIES ON MARINE BIRDS ...Albatrosses, Shearwaters... , Bermuda, Mark, Tag Or Capture -other, Spawning & Nesting Sites, ...5.0531

Penguins

DEEP DIVING ANTARCTIC BIRDS AND MAMMALS ...Adaptation, Antarctica, Locomotion -animal, Seals, Water Pressure, ...5.0555

Perching Birds - Songbirds

EXPERIMENTAL MANIPULATION OF MECHANICAL AND PHYSIOLOGICAL RHYTHMS - A DUAL APPROACH TO THE BIOLOGICAL CLOCK PROBLEM ...Acetabularia, Behavioral Ecology, Biological Rhythms, Crabs, ...5.1002

Pigeon

SENSORY BASIS OF NAVIGATION IN HOMING PIGEONS ...Behavior, Biological Rhythms, Environmental Physiology, Locomotion -animal, Mark, Tag Or Capture -other, ...4.0108

Shorebirds-gulls,terns,skimmer

RENAL SALT EXCRETION IN MARINE BIRDS ...Kidney and Urinary System, Osmoregulation, Urine, ...5.0562

SYSTEMATICS AND ECOLOGY OF MARINE BIRDS ...Animal Taxonomy, Handbooks, Range Or Territorial Distr. , World Wide, ...5.0582

Waterfowl -non-specific

ECOLOGICAL STUDIES OF THE COPPER RIVER DELTA ...Alaska, Censusing, Maps-general, Spawning & Nesting Sites, ...5.0855

EVALUATION OF ATLANTIC COAST ESTUARIES ...Atlantic Ocean-north, Estuaries, Game Reserves & Preserves, Habitat Studies, Life History Studies, ...9.0020

WATERFOWL FOOD STUDIES ...Food Supply, Management, Plant Prod. (non-specific), South Carolina, ...5.0653

OCEAN WATER INTRUSION INTO BACK BAY, VIRGINIA, & CURRITUCK SOUND, NORTH CAROLINA, ON THE

WATERFOWL & FRESHWATER FISH HABITAT ...Habitat Studies, North Carolina, Virginia, Water Salinity, ...5.0897

ECOLOGICAL STUDIES OF ATLANTIC AND GULF COASTAL ESTUARIES OF IMPORTANCE TO WATERFOWL ...Agricultural Land Use Effects, Atlantic Ocean-general, Construction Land Use Effects, Estuaries, Gulf of Mexico, Habitat Studies, ...5.0896

Black Sea

SUPPORT FOR THE OPERATION OF OCEANOGRAPHIC RESEARCH VESSELS ...Marine Biology, Mediterranean Sea-general, Sedimentation, Ships and Cruises, Water Analysis-general, ...11.0030

Blood Plasma and Serum

IONIC REGULATION IN THE QUEEN CONCH, STROMBUS GIGAS LINNAEUS ...Digestive System, Gastropods - slugs,conch,snails, Osmoregulation, ...5.0407

BLOOD CHEMISTRY OF FISHES ...Bone, Sharks, Vertebrate Anatomy, Vertical Distribution, ...5.0239

BLOOD TYPES AS INDICATORS OF BLUEFISH RACES ...Blood Cells, Blood Typing Studies, Bluefish, Immunology, Polymorphism, ...5.0319

BLOOD TYPES AS INDICATORS OF WHITE MARLIN RACES ...Blood Typing Studies, Marlin, Billfishes, Sailfish.., Polymorphism, Statistics-general, ...5.0321

IMMUNOLOGY AND SEROLOGY OF MARINE ANIMALS ...Agglutination Tests, Biochemical Analysis, Immunology, Pathology, ...5.0977

PROVIDE FOR ACTIVITIES OF TUNA BLOOD GROUP CENTER ...Blood Typing Studies, Hawaii, Immunology Methods, Tuna, Mackerel, Albacore... , ...5.0258

HEMATOLOGICAL CHANGES IN F. HETEROCLITUS UPON EXPOSURE TO TOXIC METALS ...Blood Cells, Cadmium, Killifishs - Cyprinodon, Lead, Toxins -other, ...5.0325

BLOOD PARASITES OF NORTHWEST FISHES ...Codfishes, Hake, Helminths, Protozoa, Sculpins, Trematoda -other, ...5.0335

OSMOTIC COMPONENTS IN ELASMOBRANCH BLOOD ...Chondrichthyes -other, Environmental Physiology, Osmoregulation, Water Salinity, Water Temperature-non-specific, ...5.0249

Body Temperature

Hypothermia

METABOLIC ADAPTATION TO COLD ...Cold, Female, Korea, Metabolism in Disease, Regulation, ...6.0092

Regulation

METABOLIC ADAPTATION TO COLD ...Cold, Female, Hypothermia, Korea, Metabolism in Disease, ...6.0092

SUPPORT FOR THE PHYSIOLOGICAL RESEARCH SHIP, R/V ALPHA HELIX ...Insecticides -non-specific, Mycorrhiza, Nerve Effects, Rain Forests, Tropic, ...12.0011

HUMAN TEMPERATURE REGULATION IN WATER ...Cardiac Output, Medical Studies, ...6.0094

THERMAL REGULATION DURING WATER IMMERSION OF MAN ...Calorimetry, Effects on Cardiovasc. system, ...6.0095

Borehole Geophysics

GEOTHERMAL STUDIES IN DEEP-SEA DRILL HOLES ...Abyssal, Bathyal, Core Temperature, Earth Interior, Geothermal, Heat Flow Measurements, Heat Flows, Sediments-general, Technique Development, ...7.0122

Boron

ENVIRONMENT OF DEPOSITION OF ARGILLACEOUS SEDIMENTS ...Adsorption Capacity, Chemistry, Clays, Deltas, Mississippi River, ...7.0240

PALEOSALINITY DETERMINATION BY THE BORON IN ILLITE METHOD ...Illinois, Illite, Interstitial - Connate Water, Salinity, Swamps-marshes, ...7.0238

Bottom Sampling

FARMINGTON RIVER SHAD STUDIES ...Alewife,menhaden,shad,herring, Captive Rearing, Migration, Sampling, Streams, ...5.0203

ROUTINE SAMPLING AT SEVEN INDEX STATIONS ...Data Acquisition, Fish -non-specific, Lake Erie, Plankton Sampling, Sampling, ...5.0214

Bottom Sampling Device

DESIGN AND DEVELOPMENT OF OCEANOGRAPHIC INSTRUMENTATION ...Physical Analysis, Technique Development, Water Motion Recorders, ...8.0090

DEEP-SEA AUTONOMOUS VEHICLES, INSTRUMENTS, BASIC CONTROL DEVICES, AND SPECIAL COLLECTING GEAR ...Abyssal, Organism Sampling Devices, Photography, Sampling, Submersibles, Water Motion Recorders, ...8.0122

BENTHIC COMMUNITIES ...Behavioral Ecology, Benthic Fauna, Developmental Physiology, Fouling, Metabolism, Productivity - Food Chain, ...5.0561

SEA FLOOR ROUGHNESS ...Acoustical, Attenuation, Benthonic-bottom, Magnetic Studies, Propagation, Transmission, ...7.0033

LOCATING AND MAPPING HARD BOTTOM AREAS NEAR EXISTING NATURAL SEED OYSTER BEDS ...Oysters, Spawning & Nesting Sites, ...4.0052

GEOLOGICAL AND HYDROGRAPHIC STUDY OF THE WILMINGTON SUBMARINE CANYON AND ADJACENT AREAS ...Geomorphology-topography, Model Studies, Photography, Submarine Canyons, Textures-structures, ...7.0211

SEDIMENT MOVEMENT AND BOTTOM CONDITIONS IN THE DELAWARE ESTUARY MOUTH AREA ...Currents-other, Delaware Bay, Photography, Sedimentation, Tides, ...7.0220

HEAVY METALS AND SEDIMENTATION PROCESS OF THE NORTH CAROLINA SHELF ...Continental Shelf, Heavy Minerals, Mineralogy, North Carolina, Sedimentation, ...7.0021

DEVELOPMENT OF DIAMOND DRILLING TECHNIQUES, FOR PHOSPHORITE DEPOSITS, USING STANDARD TOOLS PLUS BUOYANCY TANKS ...Disturbed/undisturbed, Drilling and Coring, Phosphate, Soil Sampling, Technique Development, ...8.0248

DEVELOPMENT OF WIRE-LINE CORING TECHNIQUE FOR SAMPLING UNCONSOLIDATED DEPOSITS ...Alaska, Coring and Dredging, Mechanical Properties, Mineralogy, Technique Development, ...8.0249

DEVELOPMENT, TESTING AND EVALUATION OF MODIFICATIONS REQUIRED TO ADAPT DRILLING SAMPLING SYSTEMS TO THE PLATFORM ...Coring and Dredging, Drilling and Coring, Equipment, Platforms, Technique Development, ...8.0256

DEVELOPMENT OF MARINE CHURN DRILL FOR SAMPLING UNCONSOLIDATED DEPOSITS ...Drilling and Coring, Soil Sampling, Technique Development, Unconsolidated Deposits, ...8.0250

SAN PABLO BAY STUDY ...Bays, Benthic Fauna, Excavation, Pollution - Effects of , Spoil Banks, ...6.0136

Brackish Water

INVENTORY OF LARVAL FISH ...Aquatic Ecology, Fish -non-specific, Maturity & Growth Stages, ...5.0071

BRACKISH WATER PURIFICATION BY BIOLOGICAL FUEL CELL POWERED ELECTRODIALYSIS ...Biological, Desalination, Desalination Wastes, Electrodialysis, Material Recovery Wastes, Water Costs, ...6.0161

CULTURE OF POMPANO IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Food Supply, Louisiana, Pompanos, Scads, Jacks, Stocking of Fish & Shellfish, ...8.0004

CULTURE OF ATLANTIC CROAKER IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Captive Rearing, Drums, Management, Ponds, Productivity (agricultural), ...8.0005

CULTURE OF RED SWAMP CRAWFISH, PROCAMBARUS CLARKI, IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Aquatic Ecology, Captive Rearing, Crayfish, ...5.0432

CULTURE OF BLUE, CHANNEL, AND WHITE CATFISH IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Blue Catfish, White Catfish, Captive Rearing, Channel Catfish, Louisiana, ...8.0006

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RELICT COPEPODS FROM LAKE TUBORG, ELLESMERE ISLAND ...Canada, Carbon-14, Copepods, Lakes, Plankton Sampling, ...5.0388

DISTRIBUTION OF ELEMENTS IN FLUVIAL AND BRACKISH ENVIRONMENTS ...Adsorption, Adsorption Capacity, Chemical Reactions, Element Ratios, Exchange Capacity, Solution, ...7.0221

EXTENT OF BRACKISH WATER IN TIDAL RIVERS, MARYLAND ...Runoff, Tides, Water Utilization -general, ...1.0100

EXPLORATORY COLLECTION AND CARE OF AQUATIC INVERTEBRATES FOR TESTING AT TIBURON ...Bioassay, Captive Rearing, Invertebrates -non-specific, Pesticides -non-specific, ...5.0905

British Isles

MONTVILLE STATION TEMPERATURE SURVEY (THAMES RIVER) ...Electric Power Plants, Estuaries, Maps-other, Temperature, Thermal Pollution, ...1.0182

British West Indies

DEVELOPMENT EXPERIMENTAL SYSTEM FOR AIR SEA INTERACTIONS ...Air-sea Boundary-general, Buoys, Meteorological Studies, ...4.0008

BIOGENESIS OF CARBONATE SEDIMENTS, BAHAMA ISLANDS ...Bioclastic Limestone, Biofacies, Biogeochemical Process, Classification - Taxonomy, Sedimentary Petrogenesis, ...7.0241

EFFECTS OF HURRICANE BETSY ON SOME BEHAMA CORAL REEFS ...General Deposition, Reefs, Tropical Cyclones, ...7.0290

SUBMARINE GEOLOGY OF THE BAHAMAS AND THE WEST INDIAN ARC ...Geology-general, Ocean Basins, Ridges, Ships and Cruises, Trenches, ...7.0038

OCEANOGRAPHY, PLEISTOCENE GEOLOGY AND SEDIMENTS OF LITTLE BAHAMA BANK ...Carbonates-general, Currents-bottom, Energy, Quaternary Period, Water Motion Recorders, ...7.0229

CARBONATE SEDIMENTATION IN THE TONGUE OF THE OCEAN, BAHAMAS ...Carbonates, Diagenesis, Paleoecology, Sea Level Variations, Sedimentation, ...7.0267

SUBSURFACE GEOLOGY OF HOGSTY REEF, AN ATOLL IN THE SOUTHEASTERN BAHAMAS ...Atolls, Paleoenvironments, Physiographic History, Quaternary Period, Submergent, Subsurface, ...7.0037

STUDIES OF THE TRANSPORT OF THE FLORIDA CURRENT ...Florida, Gulf Stream, Navigation, Ocean Currents-other, Water Motion Recorders, ...2.0017

THE SEDIMENTARY AND DIAGENETIC RECORD OF ENVIRONMENTAL PARAMETERS IN RECENT BAHAMIAN TIDAL FLATS ...Diagenesis, Environmental Effects-geologic, Intertidal Areas, Local Stratigraphy, Paleoclimatology, ...7.0163

GEOLOGICAL AND GEOPHYSICAL INVESTIGATION OF THE BAHAMA BANK ...Banks, Bathymetry, Crust, Magnetic Studies, Seismic Studies, ...7.0110

ACOUSTIC-VIDEO SYSTEM FOR AQUATIC BIOACOUSTICAL AND ETHOLOGICAL RESEARCH ...Acoustical, Behavioral Ecology, Marine Biology, Marine Environments-general, ...1.0049

AIR-SEA INTERACTION (WAVES) ...Forecasting-prediction, Heat and Radiation Transfer, Surface Environments, Waves, Wind-water Interaction, ...3.0016

WAVE GENERATION ...Profiles, Shear, Towers, Waves, Wind-water Interaction, ...2.0103

BARBADOS OCEANOGRAPHIC AND METEOROLOGICAL EXPERIMENT ...Depth, Ocean-lakes, Salinity, Temperature, Wind-water Interaction, ...3.0015

Bryozoa

PHYLOGENETIC RELATIONS OF FOSSIL AND LIVING GYMNOLAEMATES ...Fouling, Geologic, Other Bryozoa, Phylogenies, ...5.0665

THE SYSTEMATICS AND ZOOGEOGRAPHY OF THE BRYOZOAN FAUNA OF THE HAWAIIAN ISLANDS ...Animal Taxonomy, Australian, Collections, Hawaii, Range Or Territorial Distr. , ...5.0542

SYSTEMATIC AND DISTRIBUTIONAL STUDY OF DEEP-SEA ECTOPROCTA (BRYOZOA) ...Adaptation, Animal Taxonomy, Ecological, Vertical Distribution, ...5.0650

EVOLUTION OF PROVINCIAL DISTRIBUTION PATTERNS IN CHEILOSTOME BRYOZOA ...Geologic, Order Cheilostomata, Paleontology, Population - Distribution, Tertiary Period, ...7.0173

Buildings and Land Development

Construction

Equipment

FEASIBILITY STUDY ON HORIZONTAL TEST TANK FOR MODEL STUDIES AND COMPONENT TESTING ...Consultants, Advisory Services, Dredging, Model Studies, Ocean Mining, Tanks, ...12.0007

Excavation

HISTORICAL STUDY ON EFFECT OF HARBOR DREDGING ON THE ENVIRONMENT (ENVIRONMENTAL FACTORS PERTINENT TO EFFECTS ON MARINE ENVIRONMENTS) ...Dredging, Environmental Effects-geologic, Harbors, Marine Environments-general, Ocean Mining, ...6.0135

ENGINEERING EVALUATION OF EXISTING DREDGE SYSTEMS AND OPERATIONS ...Dredging, Ocean Mining, ...8.0246

SAN PABLO BAY STUDY ...Bays, Benthic Fauna, Bottom Sampling Device, Pollution - Effects of , Spoil Banks, ...6.0136

Buoyant, Flotational

PASSIVE BUOYANCY SYSTEMS ...Engineering Studies-general, Foam, Porous, Materials Used Undersea, Other-design-and-construction, Submersibles, ...8.0263

DEEP SUBMERGENCE SYSTEMS ...Geomorphology-topography, Marine Propulsion, Navigation Communication, Physical Properties, Submersibles, Welding - Other, ...8.0051

REINFORCED PLASTIC STRUCTURES ...Laminates, Materials Used Undersea, Plastic Matrix, Strength - Weight Ratio, ...8.0212

BUOYANCY MATERIALS ...Materials Used Undersea, Microsphere, Microballoon, Plastic Matrix, Submerged Ships, ...8.0214

Buoys

SATELLITE INTERROGATE ENVIRONMENTAL BUOY DEVELOPMENT ...Navigation Communication, Satellites, ...8.0308

DEVELOPMENT EXPERIMENTAL SYSTEM FOR AIR SEA INTERACTIONS ...Air-sea Boundary-general, British West Indies, Meteorological Studies, ...4.0008

MARINE METEOROLOGY UNTENDED STATION DEVELOPMENT ...Air Motion Instruments, Automatic Stations, Meteorological Studies, Platforms, Profiles, ...8.0285

AIR-SEA INTERACTION PROCESS ...Boundary Layer Studies, Circulation-general, Lakes, Profiles, Wind-water Interaction, ...3.0028

BIOLOGY AND CHEMISTRY OF MARINE PLANKTON POPULATIONS ...Chlorophyll, Phytoplankton, Vertical Distribution, Zooplankton, ...5.0798

WATER WAVE DOCUMENTATION ...California, Pacific Ocean-general, Water Motion Recorders, Waves, ...2.0094

ENERGY TRANSFER NEAR THE EARTHS SURFACE ...Air Motion Instruments, Heat and Radiation Transfer, Thermodynamics, Turbulence, ...3.0044

FORMATION OF ANTARCTIC BOTTOM WATERS ...Hydrodynamics, Oceanic Fronts, Salinity, Temperature, Weddell Sea, ...1.0152

NATIONAL DATA BUOY STUDY ...Data Acquisition, ...8.0281

GEOPHYSICAL INVESTIGATIONS IN THE CORAL SEA ...Coral Sea, Crust, Regional Structure, Seismic Refraction, Structural Studies, ...7.0130

DYNAMICS OF MOORED BUOY SYSTEMS USED IN OCEANOGRAPHY R&D AND SURVEILLANCE ...Currents-ocean, Laboratory Analysis, Model Studies, Moorings, Waves, ...8.0321

DIRECT AND INDIRECT DETERMINATION OF OCEANIC WATER MASS MOTION ON ALL SCALES ...Currents-ocean, Oceanic Fronts, Pacific Ocean-east, Salinity, Temperature, ...2.0092

OCEAN WIND WAVE GENERATION AND DISSIPATION ...General Synoptic Observations, North Sea, Velocity, Waves, Wind-water Interaction, ...2.0105

OCEANIC INTERNAL MOTIONS AFFECTING OPERATIONS ...Bermuda, Military Aspects, Thermal, Water Motion Recorders, Waves-internal, ...2.0115

AIR OCEANOGRAPHY ...Air-sea Boundary-general, Atlantic Ocean-north, Gulf Stream, Satellites, Technique Development, ...4.0163

BUOY ENGINEERING ...Experiments and Tests, Moorings, Water Motion, ...8.0309

SATELLITE COMMUNICATION TESTS ...Forecasting-prediction, Marine Environments-general, Satellites, Telemetry-other, Very High Frequency, ...4.0001

TELEMETERING BUOY SYSTEM FOR OCEANOGRAPHIC RESEARCH AND ENIVRONMENTAL PREDICTION ...Data Acquisition Systems, Meteorological Studies, Moorings, Navigation Communication, Oceanography-general, Technique Development, Telemetry-other, ...8.0268

OCEAN DYNAMICS EXPERIMENTS ...Atlantic Ocean-north, Currents-ocean, Operational Aspect, Thermal, Waves-internal, ...2.0071

OCEAN DYNAMICS EXPERIMENTS ...Moorings, Other-design-and-construction, Submersibles, Technique Development, Temperature, Water Motion Recorders, ...2.0072

OCEAN WAVES AND STRUCTURE ...Salinity, Thermocline, Tides, Water Motion Recorders, Waves, ...2.0106

DESCRIPTIVE OCEANOGRAPHY/PACIFIC ...Circulation-general, Currents-ocean, Pacific Ocean-east, Wind-water Interaction, ...2.0009

LARGE-SCALE INTERACTIONS ...Acoustical, Air-sea Boundary-general, Pacific Ocean-north, Temperature, Thermal, ...3.0006

OCEAN SYSTEM TELEMETRY STUDY ...Applied Electronics, Data Acquisition, Data Transmission Systems, Moorings, Telemetry-other, ...4.0002

DEEP OCEAN ENGINEERING TECHNOLOGY ...Abyssal, Benthonic-bottom, Experiments and Tests, Facilities, Platforms, Scientific-service-support, ...8.0270

VERTICAL CURRENT STRUCTURE IN THE GREAT LAKES ...Circulation-general, Great Lakes-general, Temperature, ...2.0033

WAVE MEASUREMENT IN THE OPEN OCEAN ...Data Acquisition, Oceanic - Pelagic, Profiles, Water Motion Recorders, Waves, ...2.0109

ADVANCED RESEARCH - SATELLITE INTERROGATED ENVIRONMENTAL BUOY ...Meteorological Studies, Navigation Communication, Satellites, Water Motion Recorders, ...8.0280

THERMO-ELECTRIC GENERATORS ...Generators, Thermoelectric, ...8.0162

OCEANOGRAPHIC RESEARCH ...Acoustical, Currents-ocean, Optical, Pressure, Seismic Studies, Sonar, ...1.0151

AMBIENT SEA NOISE ...Acoustical, Noise, Sampling, Sound Production, ...1.0013

PHYSICAL OCEANOGRAPHY ...Instrumentation-general, Model Studies, Pacific Ocean-north, ...1.0160

FIELD STUDY - CAPE COD, MASS. ...Animal Distr. (non-specific), Benthonic-bottom, Environmental Ecology, Sediments-other, Temperature, ...5.0584

SURVIVAL CRAFT DRIFT AND LEEWAY ...Air Motion Instruments, Currents-ocean, Equipment, Ocean-lakes, Operational Aspect, Tables, Compilations, Catalogs, ...6.0129

COAST GUARDS COASTAL OCEANOGRAPHIC MONITORNG NETWORK ...Automatic Stations, Instrumental Services, Recording Systems, Telemetry-other, Transducers, ...4.0006

OCEANOGRAPHY OF THE GRAND BANKS AND LABRADOR SEA ...Circulation-general, Icebergs, Labrador Current, Labrador Sea, Meteorological Studies, ...4.0124

Buried Structures

ELECTROKINETIC SOIL STUDY ...Electro-osmosis, Electroosmosis, Electrophoresis, Laboratory Analysis, Marine Soils, Stabilization, ...8.0342

Cadmium

HEMATOLOGICAL CHANGES IN F. HETEROCLITUS UPON EXPOSURE TO TOXIC METALS ...Blood Cells, Blood Plasma and Serum, Killifishs Cyprinodon, Lead, Toxins -other, ...5.0325

Calcium

ULTRASTRUCTURAL AND AUTORADIOGRAPHIC INVESTIGATION OF CALCIFICATION IN FORAMINIFERS ...Calcification, Cell Wall, Cell. organ. & Organoids -ot, Foraminifera, Histology and Cytology, Invertebrate Culture, ...5.0788

ECOLOGY OF MARINE ENDOLITHIC ALGAE ...Algae-General, Borings - Tracks - Trails, Habitat Studies, Niches, Textures-structures, ...5.0690

GEOCHEMISTRY OF CARBONATE CYCLE IN THE MARINE ENVIRONMENT ...Carbonate, Bicarbonate, Chemical Reactions, Optical, Precipitation, Removal--inorganics, ...7.0069

MECHANISMS OF CALCIUM CARBONATE DEPOSITION ...Barnacles, Biogeochemical Process, Chemical Reactions, Derivatives, Fouling, ...5.1015

EXPERIMENTAL CULTURE OF CALCAREOUS GREEN ALGAE OF CORAL REEFS ...Algal Culture, Biology, Chlorophyceae (non-specif.&ot), Growth and Differentiation, Plant Taxonomy, Reefs, ...5.0719

THE ROLE OF CALCIUM IONS IN THE MOTILITY OF SEA URCHIN AND OTHER SPERMATOZOA ...Atpase, Male Gametes, Motility and Migration, Yellow Perch, Darters, ...5.0622

STATOLITH DIFFERENTIATION IN AURELIA (JELLYFISH) ...Developmental Physiology, Differentiation Mechanism, Jelly Fish, Proprioceptors, ...5.0598

Calibration and Calibrators

BASIC ACOUSTICAL STANDARDS AND MICROPHONE CALIBRATION ...Acoustic, Acoustical, Audio Frequency, Standards, Specifications, Transducers, ...8.0076

STANDARDS FOR AUDIOMETRY ...Acoustic, Sound Level Analyzers, Standards, Specifications, Transducers, ...8.0127

California

ECOLOGICAL SURVEY OF EFFLUENT DISCHARGE AT TWO PULP MILLS IN HUMBOLDT COUNTY, CALIFORNIA ...Chemical Analysis (water), Effluents-waste Water, Pollution - Effects of , Pollution Effects, Pulp, Paper , and Logging, ...5.0858

RELATIONSHIPS BETWEEN RATES OF SEDIMENT ACCUMULATION & CHANGES WITH DEPTH OF CERTAIN MASS PHYSICAL PROPERTIES IN MARINE SEDIMENTS ...Coring and Dredging, Interstitial - Connate Water, Pacific Ocean-east, Rate of Deposition, Shear Strength, ...8.0335

WATER WAVE DOCUMENTATION ...Buoys, Pacific Ocean-general, Water Motion Recorders, Waves, ...2.0094

AN EXPERIMENTAL AND THEORETICAL STUDY OF THE MARINE AND CONTINENTAL CLIMATES OF POINT CONCEPTION TO THE MORRO BAY REGION OF CALIFORNIA ...General Synoptic Observations, Micrometeorology, Military Aspects, Shoreline - Coastline, ...3.0055

MARINE GEOLOGY ...Continental Shelf, Distribution, Ocean Waves - Currents, Sedimentation, Submarine Canyons, ...7.0260

SUBMARINE CANYONS ...Development, Erosional Features, Geomorphology-topography, Photography, Submarine Canyons, ...7.0295

MARINE VERTEBRATES OF THE CALIFORNIA PENINSULA ...Animal Taxonomy, Environmental Ecology, Range Or Territorial Distr. , Temperature, ...5.0554

SUPPORT OF RESEARCH VESSEL VELERO 4 ...Equipment Purchase Operation, Facilities, Geology-general, Instrumentation-general, Marine Biology, Training Grants, Fellowships, ...4.0115

SUPPORT OF THE RESEARCH VESSEL AHOYOHA III ...Diving and Scuba, Equipment Purchase Operation, Geology-general, Marine Biology, Ships and Cruises, ...12.0008

MIOCENE FISHES AND FISH FAUNAS AS DETERMINED FROM A STUDY OF FOSSIL OTOLITHS ...Biofacies, Boney Fish, Description of Fossils, Paleoecology, Tertiary Period, ...7.0170

APPLIED MARINE ENGINEERING PROGRAM AT SCRIPPS INSTITUTION OF OCEANOGRAPHY ...Engineering Studies-general, Harbors, Marine Biology, Marine Biology (non-specific), Other-design-and-construction, Scientific-service-support, Teaching and Research, Training Grants, Fellowships, ...11.0006

California

WAVE AND SURGE ACTION STUDY FOR LOS ANGELES-LONG BEACH HARBORS ...Harbors, Models, Surface Ships, Wave Action, Waves, ...2.0098

MARINE GEOLOGY OF THE CALIFRONIA CONTINENTAL BORDERLAND WITH EMPHASIS ON FUTURE ECONOMIC DEVELOPMENT AND GENERAL RESOURCE VALUE ...Clay Minerals-general, Continental Shelf, Heavy Elements, Mineralogy, Ocean Mining, ...7.0010

INVESTIGATE THE CAUSE OF MORTALITY OF PACIFIC OYSTERS ALONG THE CALIFORNIA COAST ...Environmental Ecology, Mortality Rates, Oysters, Pathology, Training Grants, Fellowships, ...5.0360

AVIFAUNAL ECOLOGY OF LIMANTOUR ESTERO ...Birds - non-specific, Food Supply, Game Reserves & Preserves, Habitat Studies, ...5.0534

SPORTFISH YIELD OF NATURAL REEFS ...Bays, Fishery Development -other, Habitat Studies, Population Dynamics, ...5.0199

FOOD HABITS STUDY OF ORGANISMS OF THE CALIFORNIA CURRENT SYSTEM ...Behavioral Ecology, California Current, Food Supply, Pacific Ocean-general, ...5.0044

PACIFIC OCEAN INFLUENCE UPON CALIFORNIA RAINFALL ...Forecasting, Pacific Ocean-general, Patterns, Rain-other, Temperature, ...3.0057

MARINE WASTE DISPOSAL AND SEA URCHIN ECOLOGY ...Pollution Effects, Productivity - Food Chain, Sea Urchins & Other Echinoderm, Sewage, ...5.0551

ENVIRONMENTAL BIOLOGY OF TOMALES DAY ...Aquatic Ecology, Bays, Benthic Fauna, Mans Activities, Pollution - Effects of , ...5.0860

EARTHQUAKE HAZARD - A PUBLIC POLICY PROBLEM IN THE SAN FRANCISCO BAY AREA ...Earthquakes, Faults, Forecasting-prediction, Intergovernmental Relations, Policy Making, San Francisco Bay, ...9.0002

SEDIMENTOLOGY AND GEOLOGIC HISTORY OF HUMBOLDT BAY, CALIFORNIA ...Bays, Coring and Dredging, Geologic History-general, Pacific Ocean-east, Physical Properties, ...7.0193

ECOLOGY OF STORM PETRELS ...Albatrosses, Shearwaters... , Islands, Mark, Tag Or Capture -other, Spawning & Nesting Sites, Terrestrial Ecology, ...5.0532

ZOOPLANKTON STUDIES IN BIG LAGOON, CALIFORNIA ...Lagoons, Plankton Sampling, Temporal Distribution, Vertical Distribution, Zooplankton, ...5.0739

POLLUTION STUDY OF THE VENICE DISTRICT CANAL ...Canals, Model Studies, Synthetic Hydrology, Water Quality-general, ...6.0141

A SURVEY OF THE MARINE ENVIRONMENT FROM FORT ROSS, SONOMA COUNTY, TO POINT LOBOS, MONTEREY COUNTY ...Effluents-waste Water, Marine Environments-general, Pollution - Effects of , Pollution Effects, ...9.0003

LITTORAL ENVIRONMENT OBSERVATION PROGRAM ...Development, Erosion, Intertidal Areas, ...7.0289

RADIOISOTOPIC SAND TRACER STUDY, POINT CONCEPTION, SANTA BARBARA COUNTY, CALIFORNIA ...Ocean Waves - Currents, Other Sediment Type, Sediment Transport-general, Tracers, ...7.0194

STUDY OF BEACH NOURISHMENT ALONG THE SOUTHERN CALIFORNIA COAST ...Beach, Erosional Features, Sediment Transport-general, Shoreline Structures, Supply Rate, ...7.0292

OCEANOGRAPHIC RESEARCH ...Acoustical, Anti-submarine-warfare, Military Aspects, Temperature, Transmission, ...1.0005

OREGON-CALIFORNIA BLACK SANDS ...Beaches, Heavy Mineral Analysis, Heavy Minerals, Mineralogy, Ocean Mining, Potential of Deposit, ...7.0015

NORTHERN CALIFORNIA OFFSHORE BLACK SANDS ...Distribution, Heavy Minerals, Shoreline - Coastline, Size, Terrigenous, ...7.0020

CENTRAL CALIFORNIA CONTINENTAL MARGIN ...Continental Shelf, Continental Slope, Geologic Maps, San Andreas Fault, Structural Studies, ...7.0036

UNIVERSITY OF SOUTHERN CALIFORNIA CONTRACT - CHANNEL ISLANDS AND BASINS SOUTHERN CALIFORNIA CONTINENTAL MARGIN ...Continental Shelf, Continents, General Mineralogic Properties, Geochronology-general, Mineralogy, ...7.0223

ANALYSIS AND INTERPRETATION OF DATA FROM GEOPHYSICAL AND PHOTOGRAB SURVEY OF CORONADO BANK, OFF SOUTHERN CALIFORNIA ...Ocean Mining, Phosphate, Photography, Potential of Deposit, ...7.0004

GEOLOGICAL, GEOPHYSICAL, OCEANOGRAPHIC, AND ECOLOGICAL DATA ON WORLDWIDE BASIS, ON AREAS OF HEAVY METALS POTENTIAL ...Continental Shelf, Drilling and Coring, Oregon, Placer, Potential of Deposit, ...7.0005

SAMPLING CAMPAIGN ON CORONADO BANK, OFF SOUTHERN CALIFORNIA ...Banks, Chemistry, Coring and Dredging, Distribution, Phosphate, Phosphite, ...7.0003

OREGON-NORTHERN CALIFORNIA PLACER DEPOSITS ...Deposits-ores, Drilling and Coring, Oregon, Placer, Reconnaissance, ...7.0009

EXPLORATORY COLLECTION AND CARE OF FISH FOR TESTING AT TIBURON ...Bioassay, Fish -non-specific, Laboratory Animals, San Francisco Bay, ...5.0116

LIFE HISTORY OF BILLFISHES ...Censusing, Life History Studies, Marlin, Billfishes, Sailfish.., Mexico, ...5.0195

TOXICANT TOLERANCE STUDIES-SCREENING OF PESTICIDES AND FISH AT TIBURON ...Fish -non-specific, Laboratory Animals, Pesticides -non-specific, Screening Potential Pesticides, ...5.0278

TOXICANT TOLERANCE STUDIES - SCREENING OF PESTICIDES AND AQUATIC INVERTEBRATES AT TIBURON ...Herbicides -non-specific, Insecticides -non-specific, Laboratory Animals, Screening Potential Pesticides, ...5.0906

FILM PROJECT (KELP FORESTS) ...Cinematography, Fishery Development -other, Habitat Studies, Laminariaceae (non-specif.&ot), ...5.0678

THE ROLE OF THE SENORITA, OXYJULIS CALIFORNICA, AS A CLEANING ORGANISM ...Ectoparasites, Fish -other, Fishery Development -other, Interbiotic Relat.(non-specif), ...5.0193

SAND DOLLAR COMMUNITIES ...Beaches, Habitat Studies, Productivity - Food Chain, Sea Urchins & Other Echinoderm, ...5.0533

ECOLOGY OF THE KELP FORESTS ...Behavioral Ecology, Environmental Ecology, Fish -non-specific, Habitat Studies, Laminariaceae (non-specif.&ot), ...5.0194

PACIFIC COASTAL ENVIRONMENT AS RELATED TO DISTRIBUTION AND ABUNDANCE OF GAME SPECIES -- SEA SURFACE TEMPERATURE MEASUREMENTS ...Aquatic Ecology, Spectral Reflectance, Temperature, ...1.0175

LOCAL FISHERY SYSTEMS DEVELOPMENT ...Commercial Fishing, Sharks, Shrimps - Common, Swordfish, ...5.0198

149A FISHERY SYSTEMS ANALYSIS ...Commercial Fishing, Nets, Production & Processing, Simulation, Tuna, Mackerel, Albacore... , ...4.0175

MULTISPECIES FISHERIES MODELS ...Commercial Fishing, Economics, Model Studies, Oceanic - Pelagic, Pacific Ocean-east, Production & Processing, ...4.0065

MESO WIND PATTERNS IN THE CENTRAL CALIFORNIA VALLEY ...Atmospheric Pollution-general, Drift (pesticide), Herbicides -non-specific, Land-sea Breezes, Wind Erosion, ...3.0056

ANALYSIS OF THE MARINE LAYER - A MESO METEOROLOGICAL STUDY ...Air-sea Boundary-general, Diffusion, Heat Exchange, Orographic Effects, Turbulence, ...3.0001

Calorimetry

CALORIC STUDIES OF SPARTINA AND THE MARSH CRAB SESARMA RETICULATUM ...Chlorideae (non-specific & Ot), Crabs, Energy Budgets, Swamps-marshes, ...5.0380

THERMAL REGULATION DURING WATER IMMERSION OF MAN ...Effects on Cardiovasc. system, Regulation, ...6.0095

Canada

ACOUSTIC RECORDING OF MARINE MAMMALS OF NOVA SCOTIA AND NEWFOUNDLAND ...Atlantic Ocean-north, Mammals, Seals, Sound Production, Tape Recording, Audio, ...5.0625

CORING OF THE VARVED SEDIMENTS IN SAANICH INLET ...Coring and Dredging, Geochronology-general, Local Stratigraphy, Pacific Ocean-east, Varves, ...7.0282

COHO MARKING ...Oregon, ...5.0161

THE ORIGIN OF GRAVEL BARS IN THE INTERTIDAL ZONE, PARRSBORO HARBOUR, NOVA SCOTIA, CANADA ...Intertidal Areas, Location, Origin, Sand Bars, Size, ...7.0277

INTERPRETING THE ORIGIN AND DISTRIBUTION OF COASTAL SEDIMENTS ...Distribution, Massachusetts, Origin, Shoreline - Coastline, Size, ...7.0213

MODERN VERSUS RELICT SEDIMENT PATTERNS ON CONTINENTAL MARGINS ...Bermuda, Continental Shelf, Distribution, Quaternary Period, Sea Level Changes, ...7.0214

RELICT COPEPODS FROM LAKE TUBORG, ELLESMERE ISLAND ...Brackish Water, Carbon-14, Copepods, Lakes, Plankton Sampling, ...5.0388

Canals

POLLUTION STUDY OF THE VENICE DISTRICT CANAL ...California, Model Studies, Synthetic Hydrology, Water Quality-general, ...6.0141

Cancer

EPIDERMAL PAPILLOMAS IN PLEURONECTID FISHES ...Papillomas of Animals, Pathology, Puget Sound, Righteye Flounders, ...5.0314

Carbohydrates

Cellulose

MARINE FUNGI DEGRADATION ...Fouling, Growth and Differentiation, Marine Fungi (non-specific), Nutrition Studies, ...8.0225

Glycogen

CARBON DIOXIDE FIXATION IN HETEROTROPHIC ORGANISMS III THE BREAKDOWN OF GLYCOGEN IN MARINE INVERTEBRATES ...Alanine, Carbon Dioxide Fixation, Catabolism and Degradation, Metabolism, Oxygen, ...5.1033

Mucopolysaccharides

HISTOCHEMICAL STUDIES OF MUCOSUBSTANCES IN THE MANTLE OF THE NORTHERN QUAHOG, MERCENARIA MERCENARIA ...Calcification, Clams, Derivatives, Histochemistry - Cytochem, Mucoproteins, ...5.0455

Carbon

HYDROSPHERE-ATMOSPHERE RADIOCHEMICAL MEASUREMENTS ...Diffusion, Nuclear Explosions - Fallout, Particle-gas Transfer, Tracers, Velocity, ...3.0043

C-14 UPTAKE, LIMITING FACTORS AND EXCRETION PRODUCTS OF ANTARCTIC PHYTOPLANKTON ...Antarctic Ocean, Phytoplankton, Primary Productivity, Secretions and Products, ...5.0813

NEUTRON ACTIVATION ANALYSIS OF IRON METEORITES ...Activation Analysis, Aluminum, Argon-potassium, Cosmogenous, Iron, Neutron Activation, ...7.0065

CHEMICAL OCEANOGRAPHY ...Carbon-14, Chemical Reactions, Gulf of Mexico, Organics, Reaction-general, ...1.0131

HETEROTROPHIC ACTIVITY AND PRIMARY REGENERATION IN THE OCEAN ...Atlantic Ocean-south, Biodegradation, Gulf of Mexico, Organics, Organics-general, ...1.0114

CARBON ISOTOPE GEOTHERMOMETRY ...Carbonaceous Substance, Chemistry, Core Analysis, Geologic Thermometry, Paleotemperature, Plankton (non-specific), Temperature, ...7.0079

STABLE ISOTOPE FRACTIONATION IN ECHINODERM CALCITE ...Animal Taxonomy, Biogeochemical Process, Calcite, Living Organisms, Marine Organisms, Oxygen, Sea Feathers,sea Lily... , Sea Urchins & Other Echinoderm, ...7.0085

STABLE CARBON AND OXYGEN ISOTOPE RATIO VARIATIONS IN THE FLOW TO CARBON AND OXYGEN THROUGH NORMAL AND POLLUTED AQUATIC SYSTEMS ...Element Ratios, Organic-general, Oxygen, Pollutants Path of , Sewerage Systems-other, Water Analysis, ...1.0132

OPERATION OF R/V ALAMINOS ...Caribbean Sea, Gulf of Mexico, Gulf Stream, Ships and Cruises, Textures-structures, ...12.0046

STUDY OF THE EXCHANGE OF CARBON DIOXIDE BETWEEN THE ATMOSPHERE AND THE OCEANS ...Computer Applications, Gases, Meteorological Studies, Particle-gas Transfer, ...1.0081

STUDY OF DEEP PACIFIC CIRCULATION USING SILICON-32 ...Circulation-general, General Sea Water Chemistry, Pacific Ocean-general, Silicon, Tracers, ...2.0006

DISTRIBUTION OF CARBON AND RADIUM IN THE ANTARCTIC WATERS ...Gases, Indian Ocean-general, Radium, Sampling, Trace Elements, ...1.0109

STABLE ISOTOPES ...Atlantic Ocean-north, Atlantic Ocean-south, Chemical Analysis (water), Sampling, Water Chemistry-other, ...1.0108

MICROBIAL CORROSION IN THE MARINE ENVIRONMENT ...Biodegradation, Biological, Fouling, Marine Fungi (non-specific), Water, ...5.0769

EFFECT OF NITRILOTRIACETIC ACID (NTA) UPON THE TOXICITY OF METALS TO SELECTED SPECIES OF ESTUARINE PHYTOPLANKTON ...Acids, Chemicals (incl. algacides), Estuaries, Isotope Tracer-other, Phytoplankton, ...5.0829

CARBON MONOXIDE CONTENT OF GLACIAL ICE AND THE NATURAL ATMOSPHERE ...Composition, Dispersion - Transporation, Gases, Mono-oxide, ...3.0068

Carbon Dioxide

CHEMICAL FEATURES OF THE SUBARCTIC BOUNDARY IN THE NORTHERN PACIFIC OCEAN ...Circulation-general, Gases, Mixing, Oceanic Fronts, Pacific Ocean-north, Sub - Polar, ...1.0125

BIOLOGICAL TRANSPORT OF GASES AND OTHER SUBSTANCES ...Active Transport, Carbonic Anhydrase, Fish, Gases, Kidney and Urinary System, ...5.0240

Carbonate, Bicarbonate

PHASE RELATIONS OF THE HYDRATED CARBONATES OF CALCIUM AND MAGNESIUM ...Equilibrium - Chemical, Interfacial, Phase Relationships, Properties and Structure, Surface Chemistry, ...3.0085

RESEARCH ON THE PHYSICAL CHEMISTRY OF CHEMICAL REACTIONS IN SEA WATER ...Acids, Apatite-general, Chemical Reactions, Equilibrium - Chemical, High Pressure Research, Reaction-general, Solubility, Sulfate, Sulfite, ...1.0127

GEOCHEMISTRY OF CARBONATE CYCLE IN THE MARINE ENVIRONMENT ...Calcium, Chemical Reactions, Optical, Precipitation, Removal--inorganics, ...7.0069

Cardiovascular System

Basic Hemodynamics

CARDIOVASCULAR STUDIES ON DIVING MAMMALS ...Adaptation, Cardiovascular System, Control and Regulation, Heart, Locomotion -animal, Seals, ...5.0639

Effects on Cardiovasc. system

CIRCULATORY REACTIONS TO ASPHYXIA ...Cardiovascular System, Mammals, Veterinary Science, ...5.0553

THERMAL REGULATION DURING WATER IMMERSION OF MAN ...Calorimetry, Regulation, ...6.0095

CARDIOVASCULAR ADJUSTMENTS IN DIVING MAMMALS ...Adaptation, Cardiovascular System, Locomotion -animal, Mammals, ...5.0674

Heart

PHYSIOLOGY OF THE LIMULUS HEART ...Biological Rhythms, Cardiovascular, Horseshoe Or King Crabs, Nervous System, ...5.0463

CARDIOVASCULAR STUDIES ON DIVING MAMMALS ...Adaptation, Basic Hemodynamics, Cardiovascular System, Control and Regulation, Locomotion -animal, Seals, ...5.0639

Regional Blood Flow & Volume

CARDIOVASCULAR ADJUSTMENT TO DIVING ASPHYXIA ...Cardiovascular System, Locomotion -animal, Medical Studies, Seals, ...5.0552

Cardiovascular Techniques

Cardiac Output

HUMAN TEMPERATURE REGULATION IN WATER ...Medical Studies, Regulation, ...6.0094

Flow Metering Techniques

MECHANICAL PROPERTIES OF MAMMALIAN CELLS ...Blood Cells, Cellular Membranes (non-spec.), Suspension Culture, Time-lapse Photography, ...5.0992

Caribbean Sea

EXPERIMENTAL VERFICATION OF WIDE SWATH OCEAN BOTTOM CONTOURING WITH SPLIT BEAM RECEIVERS ...Bathymetry, Receivers, Sonar, Technique Development, Topographic, ...7.0302

MARINE GEOPHYSICS ...Geomorphology-topography, Geophysical Equipment, Heat Flow Measurements, Magnetic Studies, Structural Studies, ...7.0115

MARINE PHYSICAL GEODESY ...Aerospatial, Gravity Studies, Navigation, Sea Level Variations, Standard Geoid, ...4.0058

GRAVITY ...Anomalies, Geophysical Equipment, Gravity, Navigation, Pacific Ocean-west, ...7.0142

CIRCULATION STUDIES ...Acoustical, Dispersion, Ocean Currents-other, Transmission, Water Properties-general, ...1.0046

ECOLOGY OF PHYTOPLANKTON IN SEMI-TROPICAL ENVIRONMENTS ...Phytoplankton, Range Or Territorial Distr. , Sub - Tropic, Temporal Distribution, Vertical Distribution, ...5.0778

RELATIONSHIPS BETWEEN PHYTOPLANKTON AND ZOOPLANKTON IN THE CARIBBEAN SEA ...Interbiotic Relat.(non-specif), Phytoplankton, Sargassum, Vertical Distribution, Zooplankton, ...5.0779

SUPPORT OF THE R/V EASTWARD ...Continental Shelf, Cooperative-studies, Facilities, Marine Biology (non-specific), Ships and Cruises, Training Grants, Fellowships, ...12.0039

COOPERATIVE RESEARCH AND TRAINING PROGRAM IN BIOLOGICAL OCEANOGRAPHY ...Facilities, Marine Biology (non-specific), Meetings, Ships and Cruises, Training Grants, Fellowships, ...11.0037

OPERATION OF R/V ALAMINOS ...Carbon, Gulf of Mexico, Gulf Stream, Ships and Cruises, Textures-structures, ...12.0046

OCEAN-SEDIMENTS AND CRUSTAL STRUCTURES IN THE BHAMIAN-CARIBBEAN AREA ...Continental Slope, Crust, Ocean Basins, Soil Properties - Other, Textures-structures, ...7.0109

CARIBBEAN GEOGRAPHY ...Beach, Central America, Shore Features-general, Shoreline - Coastline, South America, ...7.0288

DISTRIBUTION AND MIGRATION OF CENTRAL AMERICAN FRESHWATER ELASMOBRANCHS ...Migration, Nicaragua, Osmoregulation, Rays, Skates, Mantas, Sawfish, Sharks, ...5.0117

GEOLOGIC INVESTIGATIONS IN PUERTO RICO & THE CARIBBEAN ...Element Ratios, Plutonic, Puerto Rico, Sedimentary Petrology, Volcanic, ...7.0042

SHIPBOARD METHODS OF CHEMICAL ANALYSIS ...Gases, Mass Spectroscopy, Solubility, Technique Development, Water Analysis-general, ...1.0091

THE TAXONOMY AND ZOOGEOGRAPHY OF THE POLYCHAETOUS ANNELIDS OF THE GULF OF MEXICO AND THE CARIBBEAN SEA ...Animal Taxonomy, Gulf of Mexico, Lugworms, Marine Segmentedworm, Neotropical, ...5.0569

THE BIOLOGY OF ROCK-BORING SIPUNCULIDS ...Invertebrate Nutrition, Invertebrate Physiology, Invertebrates -non-specific, Reefs, ...5.0577

REPRODUCTIVE BIOLOGY, DEVELOPMENT, AND SYSTEMATICS OF THE SIPUNCULIDS OF THE CARIBBEAN ...Animal Taxonomy, Developmental Physiology, Invertebrates -non-specific, Range Or Territorial Distr. , Reproductive System, ...5.0579

SYNECOLOGY OF CARIBBEAN SPONGES ...Algae- General, Copepods, Porifera, Symbiosis, ...5.0580

SEA SURFACE SURVEILLANCE ...Circulation-general, Temporal Distribution, Tuna, Mackerel, Albacore... , Vertical Distribution, Water Properties-general, ...2.0019

STOCK IDENTIFICATION OF ATLANTIC TUNAS ...Atlantic Ocean-general, Electrophoresis -non-specific, Tuna, Mackerel, Albacore... , ...5.0252

NEW DRUGS FROM THE SEA, ESPECIALLY ANTIBIOTICS ...Antibiotics, Marine Plants, Pacific Ocean-general, ...6.0123

Caroline Islands

MICRONESIAN NAVIGATION AND SAILING ...Anthropology -other, General Ethnology, Micronesia, Navigation, Navigation Communication, ...4.0094

INVESTIGATE TUNA RESOURCES OF THE TRUST TERRITORIES ...Commercial Fishing, Environmental Ecology, Population Dynamics, Tuna, Mackerel, Albacore... , ...5.0085

Carotenoid Pigments

CAROTENOIDS, CAROTENOID CHROMOPROTEINS, AND ASSOCIATED LIPIDS IN ANIMALS ...Catabolism and Degradation, Metabolism, Pigments - Animal-non-specific, ...5.0944

PROCESSING ALASKA SHRIMP ...Design, Machinery, Equipment, Heat, Organoleptic Studies, Shrimp, Temperature Control, ...6.0002

Caulerpin

PHYTOCHEMISTRY OF NARCOTIC PRINCIPLES IN CAULERPA. ...Caulerpa, Phaeophyta (non-specific & Ot), Rhodophyta (non-specific & Ot), Sterols, ...6.0111

Cell Organelles & Organoides

Acrosomes

STRUCTURE AND FUNCTION OF CELL ORGANELLES DURING GROWTH AND DEVELOPMENT ...Basic Embryology, Differentiation Mechanism, Nucleolus, Ribosomes, ...5.0935

Cell Center & Mitot. apparatus

CELL DIVISION AND MITOTIC APPARATUS PROTEINS ...Biosynthesis , Cell Cycle, Centrioles, Proteins, Sea Urchins & Other Echinoderm, ...5.0666

Centrioles

CELL DIVISION AND MITOTIC APPARATUS PROTEINS ...Biosynthesis, Cell Center & Mitot. apparatus, Cell Cycle, Proteins, Sea Urchins & Other Echinoderm, ...5.0666

Cell Wall

ULTRASTRUCTURAL AND AUTORADIOGRAPHIC INVESTIGATION OF CALCIFICATION IN FORAMINIFERS ...Calcification, Calcium, Cell. organ. & Organoids -ot, Foraminifera, Histology and Cytology, Invertebrate Culture, ...5.0788

BIOCHEMICAL STUDIES ON SILICEOUS SKELETAL FORMATION ...Algae- Diatoms, Golgi Apparatus, Histochemistry - Cytochem, Plant Developmental Biology, Silicon, ...5.0750

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BIOLOGY-MIDDLE EAST WATERS ...Cell Cycle, Marine Biology (non-specific), Middle-east-general, Phenology, Red Sea, Reproductive System, ...5.0929

Intracellular Localization

MORPHOGENESIS OF THE DIATOM SHELL ...Algae-Diatoms, Cellular Membranes (non-spec.), Organelle & Membrane Formation, Plant Developmental Biology, Silica, ...5.0712

MEASUREMENT OF THE RATE OF CARBON DIOXIDE (C14) FIXATION INTO SUBCELLULAR FRACTIONS OF ALGAE ...Algae- General, Algal Culture, Bioindicators, Carbon, Carbon Dioxide Fixation, Growth Rate, ...5.0728

Membrane Permeability & Exch.

Active Transport

UPTAKE AND ASSIMILATION OF ORGANIC COMPOUNDS IN MARINE ORGANISMS ...Invertebrates -non-specific, Metabolism, Nutrition, Organics, Productivity - Food Chain, ...5.0937

WATER AND SALT REGULATION IN NEREID POLYCHAETES ...Comparative Physiology, Lugworms, Marine Segmentedworm, Osmoregulation, Salt, ...5.0648

INTESTINAL ADSORPTION AND TRANSPORT OF NUTRIENTS IN ECHINODERANS ...Cellular Or Intracellular, Echinodermata -other, Intestine, Metabolism, Sodium, ...5.0619

PHYSALIA TOXIN AND THE ACTIVITY OF BIOLOGICAL MEMBRANES ...Animal Toxins, Cellular Membranes (non-spec.), Jelly Fish, Toxicology, ...6.0107

ULTRASTRUCTURE OF CELL ION TRANSPORT MECHANISMS ...Electron Microscopy, Mitochondrial Membranes, Nutrition and Metabolism, Osmoregulation, Respiratory System, ...5.0974

REGULATION OF IONIC CONSTITUTENTS OF PROTOPLASM ...Dermal, Ions (inorganic), Musculoskeletal System, Nervous System, Osmoregulation, ...5.0970

CELLULAR DIFFERENTIATION ...Basic Embryology, Differentiation Mechanism, Frogs, Ionic Effect, Skin Or Special Derivatives, ...5.0618

BIOLOGICAL TRANSPORT OF GASES AND OTHER SUBSTANCES ...Carbon Dioxide, Carbonic Anhydrase, Fish, Gases, Kidney and Urinary System, ...5.0240

ION TRANSPORT MECHANISM IN GIANT AXON ...Atpase, Cell Free Metabolism, Nervous System, Octopus, Squid, Cuttlefish... , Plasma Membrane, ...5.0369

Gases

BIOLOGICAL TRANSPORT OF GASES AND OTHER SUBSTANCES ...Active Transport, Carbon Dioxide, Carbonic Anhydrase, Fish, Kidney and Urinary System, ...5.0240

Permeability

MACROMOLECULAR BASIS FOR ADAPTATION TO SALINITY CHANGES IN PRYMNESIUM PARVUM ...Adaptation, Growth Rate, Ionic Effect, Prymnesium, Water Salinity, ...5.1012

IONIC PERMEABILITIES OF THE SQUID GIANT AXON. - EFFECTS OF CHEMICAL AGENTS ...Cellular Physiology, Microelectrodes, Nervous System, Octopus, Squid, Cuttlefish... , ...5.0979

RESEARCH STUDIES IN MOLECULAR PHARMACOLOGY ...Anesthetic, Bonding and Binding, Diving and Scuba, Mechanism of Action, Thermodynamics, ...6.0100

Water Movement

GROWTH AND CELLULAR MORPHOGENESIS IN NITELLA ...Elongation of Cell, Growth and Differentiation, Manometers, Nitella, Plant Developmental Biology, ...5.0721

Metabolism (intracellular)

PHYSIOLOGICAL CHARACTERIZATION OF CERTAIN MARINE BACTERIA ...Bact. morphology (general), Bacterial Culture, Biology, Isolation From Nat. environ. , Marine Bacteria, Tissue Techniques, ...5.0784

ELUCIDATION OF THE METABOLIC PATHWAYS OF MARINE PLANKTONIC ORGANISMS ...Marine Biology (non-specific), Organelle-enzyme Assn, Plankton (non-specific), Purification & Isolate, Reaction Rates, ...5.0828

NITROGEN METABOLISM IN MOLLUSCS ...Biochemical, Evolutionary Studies-general, Gastropods -slugs,conch,snails, Metabolism, Nitrogen, ...5.0506

Amino Acids

UPTAKE OF ORGANIC COMPOUNDS BY MARINE INVERTEBRATES ...Amino Acids -non-specific, Chemoreceptors, Invertebrate Nutrition, Invertebrates -non-specific, Marine Biology, Metabolism, Pulse-labelling, ...5.0938

Autotrophic

BIOLUMINESCENCE ...Bays, Bioluminescence, Jamaica, Phytoplankton, Responses to Growth, ...1.0165

CIRCADIAN RHYTHM IN PHOTOSYNTHESIS IN THE MARINE ALGAE GONYAULAX AND ACETABULARIA ...Acetabularia, Biological Rhythms, Control and Regulation, Gonyaulax, Kinetics, ...5.0685

PHOTOBIOLOGICAL STUDIES ON MARINE CHRYSOMONADS ...Coccoliths, Elect Trans and Redox, Photochemistry, Photosynthetically Active, ...5.0932

METABOLISM OF COMPLETE WATER COLUMNS ...Antarctic Ocean, Energy Budgets, Metabolism, Respiration, ...5.0967

LIGHT REQUIREMENTS FOR MARINE ALGAE ...Algae-General, Algal Culture, Light, Marine Plants, Pigments, ...5.0703

THE ROLE OF SULFUR BACTERIA IN CORROSION AND DETERIORATION ...Biological, Fouling, Marine Bacteria, Plasma Membrane, Sulfur Bacteria, ...5.0805

OXYGEN RESOURCES OF TIDAL WATERS ...Marine Biology (non-specific), Oxygen, Oxygen Content -water, Pollution Sources-general, Tides, ...1.0119

NITRIFICATION BY MARINE MICROORGANISMS ...Bact. morphology (general), Bacterial Culture, Isolation From Nat. environ. , Marine Bacteria, Nitrogen Bacteria, Range Or Territorial Distr. , ...5.0800

Bioenergetics

CELL DIVISION, BIOENERGETICS, CHEMISTRY OF MUSCLE ...Cell Cycle, Configuration, Glyoxal, Organic, ...5.0987

STUDIES OF THE AEROCOCCUS-PEDIOCOCCUS BACTERIA ...Classification Or Taxonomy, Composition of Macromolecules, Detection, Pediococcus, ...5.0817

Biosynthesis

IONOCYTE FORMATION IN GILL EPITHELIUM OF FISHES ...Developmental Physiology, Differentiation Mechanism, Fish, Fish -non-specific, Osmoregulation, ...5.0301

MOLECULAR ASPECTS OF CELLULAR DIFFERENTIATION AND DIVISION ...Basic Embryology, Cell Cycle, Differentiation Mechanism, Proteins, Replication, Sea Urchins & Other Echinoderm, ...5.0985

MACROMOLECULAR EVENTS OF FERTILIZATION AND EARLY EMBRYONIC DEVELOPMENT ...Basic Embryology, Reproductive System, Ribosomes, Sea Urchins & Other Echinoderm, ...5.1011

GROWTH AND DIFFERENTIATION OF PLASTIDS ...Acetabularia, Cytoplasmic Inheritance, DNA Other, Nucleus (non-specific & Ot.), Organelle Culture, Photosynthetically Active, ...5.0683

AN EXPERIMENTAL APPROACH TO THE GENETIC CONTROL OF MORPHOGENESIS IN ECHINODERMS ...Developmental Physiology, Disease & Anomalies, Sea Urchins & Other Echinoderm, ...5.0608

MOLECULAR STUDIES OF DIFFERENTIATING CELLS ...Basic Embryology, Differentiation Mechanism, ...5.0984

LIGHT RECEPTOR CONTROL OF THE DIURAL RHYTHM OF ENZYME SYNTHESIS IN THE BIOLUMINOSCENT MARINE DINOFLAGELLATE GONYAULAX POLYEDRA ...Biological Rhythms, Control and Regulation, Gonyaulax, Photoreception, Plant Enzymes, ...5.0760

CELL DIVISION AND MITOTIC APPARATUS PROTEINS ...Cell Center & Mitot. apparatus, Cell Cycle, Centrioles, Proteins, Sea Urchins & Other Echinoderm, ...5.0666

FORMATION AND UTILIZATION OF TERPENES ...Anthozoa, Enzyme-substrate, Symbiosis, Terpenes, Zooxanthella, ...5.0957

PROTEIN SYNTHESIS ACTIVATION IN SEA URCHIN EGGS ...Basic Embryology, Metabolism, Proteins, Reproductive System, Sea Urchins & Other Echinoderm, ...5.0543

AN ANALYSIS OF DEVELOPMENT IN ARTEMIA SALINA EMBRYOS ...Basic Embryology, Nucleic Acids, Proteins, Ribosomes, Shrimps - Brine Or Fairy, ...5.0406

BIOSYNTHESIS OF 3-HYDROXYTYRAMINE IN MONOSTROMA FUSCUM ...Chlorophyceae (non-specif.&ot), Dopa Decarboxylase, Marine Plants, Tyramine, Tyrosinase, ...5.0720

STUDY OF TOXIN SYNTHESIS IN PRYMNESIUM PARVUM ...Algal Toxins, Axenic Culture, Gonyaulax, Gymnodinium, Prymnesium, ...6.0124

Carbohydrates

STUDIES ON MICROBIAL SULFATE REDUCTION AND SULFIDE OXIDATION IN MARINE ENVIRONMENTS ...Classification Or Taxonomy, Growth (non-specific & Ot.), Isolation From Nat. environ. , Respiration, Sulfur Bacteria, ...5.0797

STANDING STOCK AND GROWTH OF BACTERIA IN THE SEA ...Atp X Adenosine Triphosphate, Growth (non-specific & Ot.), Marine Biology, Phytoplankton, Standing Crops, ...5.0749

Carbon Dioxide Fixation

CARBON DIOXIDE FIXATION IN HETEROTROPHIC ORGANISMS III THE BREAKDOWN OF GLYCOGEN IN MARINE INVERTEBRATES ...Alanine, Catabolism and Degradation, Glycogen, Metabolism, Oxygen, ...5.1033

MEASUREMENT OF THE RATE OF CARBON DIOXIDE (C14) FIXATION INTO SUBCELLULAR FRACTIONS OF ALGAE ...Algae- General, Algal Culture, Bioindicators, Carbon, Growth Rate, Intracellular Localization, ...5.0728

Catabolism and Degradation

MICROBIOLOGICAL INVESTIGATIONS OF THRESHOLD PANELS ...Degradation, Freshwater Mussels, Scallops, Marine Bacteria, Marine Fungi (non-specific), Wood, Wood Preservatives-non-specif, ...8.0243

CAROTENOIDS, CAROTENOID CHROMOPROTEINS, AND ASSOCIATED LIPIDS IN ANIMALS ...Carotenoid Pigments, Metabolism, Pigments - Animal-non-specific, ...5.0944

DETERMINATION OF CHLOROPHYLL DERIVATIVES ...Cell Injury and Autolysis, Fluorometry, Marine Plants, Phytoplankton, ...5.0770

CARBON DIOXIDE FIXATION IN HETEROTROPHIC ORGANISMS III THE BREAKDOWN OF GLYCOGEN IN MARINE INVERTEBRATES ...Alanine, Carbon Dioxide Fixation, Glycogen, Metabolism, Oxygen, ...5.1033

ORGANIC DEBRIS ON CONNECTICUT BEACHES AND SHORES ...Connecticut, Identification, Organic Matter, Physical-general, Shoreline - Coastline, ...6.0143

Cell Free Metabolism

ION TRANSPORT MECHANISM IN GIANT AXON ...Active Transport, Atpase, Nervous System, Octopus, Squid, Cuttlefish... , Plasma Membrane, ...5.0369

Control and Regulation

CIRCADIAN RHYTHM IN PHOTOSYNTHESIS IN THE MARINE ALGAE GONYAULAX AND ACETABULARIA ...Acetabularia, Autotrophic, Biological Rhythms, Gonyaulax, Kinetics, ...5.0685

MOLECULAR MECHANISMS IN BIOLOGICAL CLOCKS ...Gonyaulax, Marine Plants, ...5.0983

BIOCHEMISTRY OF DEVELOPMENT ...Basic Embryology, Differentiation Mechanism, Messenger RNA , Sea Urchins & Other Echinoderm, Tryptophan Oxidase, ...5.0994

INDUCTION AND CONTROL OF DIFFERENTIATION IN ALGAE ...Differentiation Mechanism, Nutrition Studies, Photoperiodism, Plant Developmental Biology, Rhodophyta (non-specific & Ot), ...5.0708

DEGRADATION OF MARINE SURFACES BY SALT REQUIRING BACTERIA ...Dna-satellite, Fouling, Halophilic Bacteria, Isolation From Nat. environ. , Metabolic-biochemical Genetics, ...5.0818

LIGHT RECEPTOR CONTROL OF THE DIURAL RHYTHM OF ENZYME SYNTHESIS IN THE BIOLUMINOSCENT MARINE DINOFLAGELLATE GONYAULAX POLYEDRA ...Biological Rhythms, Biosynthesis, Gonyaulax, Photoreception, Plant Enzymes, ...5.0760

Ions (inorganic)

MARINE SULFUR OXIDIZING BACTERIA ...Habitat Studies, Isolation From Nat. environ. , Marine Bacteria, Range Or Territorial Distr. , Thiobacillus, ...5.0758

REGULATION OF IONIC CONSTITUTENTS OF PROTOPLASM ...Active Transport, Dermal, Musculoskeletal System, Nervous System, Osmoregulation, ...5.0970

Lipids

LIPID COMPOSITION OF ANTARCTIC MARINE ORGANISMS AND SEA WATER ...Antarctic Ocean, Fish -non-specific, Gulf of Mexico, Low Temp. -but Above 32f, Phytoplankton, Productivity - Food Chain, Zooplankton, ...5.1031

LIPASE RESISTANT GLYCERIDES ...Fats, Fats and Oils -other, Fish eother, Unsaturated Fats, ...5.1029

Nitrogen Fixation

DYNAMICS OF THE NITROGEN CYCLE IN THE SEA ...General Sea Water Chemistry, Nitrate, Nitrite, Nitrogen, Tracers, ...5.0933

Nucleic Acids

BIOSYNTHETIC PROCESSES DURING DEVELOPMENT OF SEA URCHIN EGGS ...Basic Embryology, Cell Cycle, Messenger RNA , Proteins, Sea Urchins & Other Echinoderm, ...5.0775

ISOLATION AND FUNCTION OF OVARIAN EXTRACTS CAPABLE OF INDUCING COCYTE SHEDDING AND OCYTE NUCLEAR MATURATION IN STARFISH ...Differentiation Mechanism, Female, Hormones, Reproductive System, Starfishes, ...5.0620

CELL TRANSFORMATIONS, DIVISION, AND MOTION ...Ameboid Movement, Basic Embryology, Cell Cycle, Microtubules, ...5.0234

AN ANALYSIS OF DEVELOPMENT IN ARTEMIA SALINA EMBRYOS ...Basic Embryology, Biosynthesis, Proteins, Ribosomes, Shrimps - Brine Or Fairy, ...5.0406

Nutrition

UPTAKE AND ASSIMILATION OF ORGANIC COMPOUNDS IN MARINE ORGANISMS ...Active Transport, Invertebrates - non-specific, Metabolism, Organics, Productivity - Food Chain, ...5.0937

COMPARATIVE PHYSIOLOGY OF BAROPHILIC BACTERIA ...Ionic Effect, Isolation From Nat. environ. , Marine Bacteria, Pressure & Mech Stress, Temperature, ...5.0751

MICROBIAL TRANSFORMATIONS IN SEA WATER ...Chemostat, Growth Rate, Isolation From Nat. environ. , Marine Bacteria, Organics, ...5.0796

STUDIES OF THE EFFECTS OF NUTRIENTS ON THE GROWTH OF PHYTOPLANKTON IN THE TROPICAL PAC. OCEAN ...Algal Culture, Growth Rate, Pacific Ocean-general, Phytoplankton, Tropic, ...5.0948

Pigments

LIGHT REQUIREMENTS FOR MARINE ALGAE ...Algae-General, Algal Culture, Autotrophic, Light, Marine Plants, ...5.0703

Proteins

BIOLOGICAL PRODUCTIVITY IN THE SARGASSO SEA, THE GULF STREAM AND IN THE ATLANTIC COASTAL WATERS OFF CAPE HATTERAS ...Continental Shelf, Phytoplankton, Primary Productivity, Productivity - Food Chain, ...5.1005

BIOSYNTHETIC PROCESSES DURING DEVELOPMENT OF SEA URCHIN EGGS ...Basic Embryology, Cell Cycle, Messenger RNA , Nucleic Acids, Sea Urchins & Other Echinoderm, ...5.0775

MOLECULAR ASPECTS OF CELLULAR DIFFERENTIATION AND DIVISION ...Basic Embryology, Biosynthesis, Cell Cycle, Differentiation Mechanism, Replication, Sea Urchins & Other Echinoderm, ...5.0985

CYTOPLASMIC FILAMENTS AND CELL MOVEMENT IN DEVELOPMENT ...Basic Embryology, Fibrils and Filaments, Growth (non-specific & Ot.), Motility and Migration, Sea Squirts - Tunicates, ...5.1037

CILIA DIFFERENTIATION IN THE SEA URCHIN EMBRYO ...Basic Embryology, Cilia and Flagella, Differentiation Mechanism, Sea Urchins & Other Echinoderm, Subunits, ...5.0616

PROTEIN SYNTHESIS DURING THE EARLY DEVELOPMENT OF THE SEA URCHIN EMBRYO ...Basic Embryology, Cell Injury and Autolysis, Radiation Effects-non-specific, Ribosomes, Sea Urchins & Other Echinoderm, ...5.0537

CELL DIVISION AND MITOTIC APPARATUS PROTEINS ...Biosynthesis, Cell Center & Mitot. apparatus, Cell Cycle, Centrioles, Sea Urchins & Other Echinoderm, ...5.0666

PROTEIN SYNTHESIS ACTIVATION IN SEA URCHIN EGGS ...Basic Embryology, Biosynthesis, Metabolism, Reproductive System, Sea Urchins & Other Echinoderm, ...5.0543

AN ANALYSIS OF DEVELOPMENT IN ARTEMIA SALINA EMBRYOS ...Basic Embryology, Biosynthesis, Nucleic Acids, Ribosomes, Shrimps - Brine Or Fairy, ...5.0406

Respiration

STUDIES OF PROTEINS UNDER EXTREME ENVIRONMENTS ...Cellular Membranes (non-spec.), Cytochromes, Exobiology, Halobacteria, Salt, ...5.0941

STUDIES ON MICROBIAL SULFATE REDUCTION AND SULFIDE OXIDATION IN MARINE ENVIRONMENTS ...Carbohydrates, Classification Or Taxonomy, Growth (non-specific & Ot.), Isolation From Nat. environ. , Sulfur Bacteria, ...5.0797

METABOLISM OF COMPLETE WATER COLUMNS ...Antarctic Ocean, Autotrophic, Energy Budgets, Metabolism, ...5.0967

RESEARCH ON THE ROLE OF BACTERIA IN THE OCEAN ...Denitrification, Elect Trans and Redox, Marine Bacteria, Microorganism Enzymes, Nitrogen Bacteria, ...5.0783

MICROBES AND CORROSION ...Cathodic Protection, Extracellular-enzymes, Fouling, Iron, Metals -non-specific, Microorganisms (non-specific), ...8.0228

Structural Functions

CYTOLOGICAL CHARACTERISTIC ...Animal Taxonomy, Basic Embryology, Porifera, Speciation, ...5.0557

MORPHOGENESIS OF THE DIATOM SHELL ...Algae-Diatoms, Cellular Membranes (non-spec.), Plant Developmental Biology, Silica, ...5.0734

GAMETOGENESIS AND FERTILIZATION IN THE BLUE CRAB, CALLINECTES SAPIDUS RATHBUN, AND OTHER CRABS ...Crabs, Electron Microscopy, Histochemistry - Cytochem, Reproductive System, ...5.0478

METABOLISM OF NEUROHUMORAL TRANSMITTER SUBSTANCES IN MARINE ANIMALS ...Animal Toxins, Basic Studies, Mech of Transmission, Metabolic Inhibitors, ...5.0981

SUBCELLULAR REACTION TO INJURY IN THE KIDNEY ...Cell Injury and Autolysis, Cellular Membranes (non-spec.), Electron Microscopy, Kidney, Toads, ...5.0297

STRUCTURAL AND FUNCTIONAL ORGANELLE INTERACTIONS ...Differentiation Mechanism, Marine Plants, Organelle & Membrane Formation, Plant Developmental Biology, Tissue Techniques, ...5.0689

Turnover (metabolic)

PRIMARY PRODUCTION AND DECOMPOSITION IN ESTUARINE WATER ...Estuaries, Florida, Methane Bacteria (non-specif.), Phaeophyta (non-specific & Ot), Primary Productivity, Rhodophyta (non-specific & Ot), ...5.0954

Organelle & Membrane Formation

MORPHOGENESIS OF THE DIATOM SHELL ...Algae-Diatoms, Cellular Membranes (non-spec.), Intracellular Localization, Plant Developmental Biology, Silica, ...5.0712

STRUCTURAL AND FUNCTIONAL ORGANELLE INTERACTIONS ...Differentiation Mechanism, Marine Plants, Plant Developmental Biology, Structural Functions, Tissue Techniques, ...5.0689

Surface Properties

Adhesion

CELL CONTACT IN RELATION TO GROWTH AND MORPHOGENESIS ...Basic Embryology, Cellular Membranes (non-spec.), Electron Microscopy, Porifera, ...5.0996

BIOCHEMICAL BASIS OF SPECIFIC CELL ASSOCIATION ...Basic Embryology, Chickens, Pacific Ocean-general, Porifera, ...5.0946

Adsorption & Interface

MECHANISMS OF ATTACHMENT OF MARINE BACTERIA TO SURFACES ...Biological, Corrosion Prevention-other, Fouling, Marine Bacteria, ...5.0810

BIOCHEMISTRY OF MARINE ORGANISMS ...Bioluminescence, Fouling, Phytoplankton, Plant Succession, Spectroscopy, ...5.0766

Surface Properties -other

CONTINUED STUDIES ON THE INFLUENCE OF THE EGG CORTEX ON THE DEVELOPMENT OF THE MOLLUSCAN EMBRYO ...Basic Embryology, Differentiation Mechanism, Gastropods -slugs,conch,snails, Octopus, Squid, Cuttlefish... , Plasma Membrane, ...5.0423

Central America

CARIBBEAN GEOGRAPHY ...Beach, Caribbean Sea, Shore Features-general, Shoreline - Coastline, South America, ...7.0288

Ceramics

Glass

VISCOSITY AND VISCOELASTICITY OF LIQUIDS AND GLASSES ...Instrumental Services, Liquid, Morphology, State Variables - Pvt, Viscoelasticity, Viscosity, ...8.0260

STRENGTH OF GLASS ...Strength, Cohesion, Stress Rupture, Submersibles, ...8.0206

STRUCTURAL PLASTICS-DEEP SUBMERGENCE ...Design Data, Epoxies, Fiber, Filament, Materials Used Undersea, Plastic Matrix, ...8.0213

Cesium

STUDY OF THE DISTRIBUTION OF RADIONUCLIDES IN THE OCEAN DETAILED EXPLORATION OF CS137 IN THE OCEAN ...Chemical Analysis (water), Circulation-general, Convection, Pacific Ocean-north, Radioactivity, ...1.0080

Channels

HARBOR DESIGN STUDIES ...Harbors, Navigation, Waves, ...8.0046

SHOALING PROCESSES ...Sand Bars, Scouring, Sediment Transport-other, Tidewater Areas, Turbulent Flow, ...7.0250

UNSTEADY FLOW AND SALINE INTRUSION IN ESTUARIES ...Computer Applications, Model Studies, Morphology-general, Saline Water Intrusion, Unsteady Flow, ...2.0066

BAYOU LAFOURCHE SEDIMENTATION STUDY. LOUISIANA ...Bayous, Louisiana, Morphology-general, Rate of Deposition, Sediment Yield, ...9.0010

Chemical & Physical Properties

Concentration

Other

SEDIMENTARY GEOCHEMISTRY ...Authigenesis , Precipitation, Removal--inorganics, Water Chemistry-other, ...7.0190

pH

PH STANDARD REFERENCE MATERIALS FOR USE IN SEA WATER ...Salinity, Standards, Specifications, Water Analysis, Water Chemistry-other, ...1.0087

Density

HYDROGEN PROPERTIES ...Dielectric Properties, Fuel Cell-other, Hydrogen, Marine Propulsion, Refraction, ...8.0157

OXYGEN PROPERTIES ...Liquid Propellant Rock, Oxidizers, Oxygen, Specific Heat, State Equations, Thermodynamic Relation, ...8.0174

Diffusion

PHYSICAL CHEMISTRY OF BUBBLES ...Bubble, Interface, Particle-gas Transfer, Surface Energy, ...1.0082

Electrical

Conductivity

PROPERTIES OF SEA WATER ...Compressibility--gas-liq, Density, Electrical, Expansion, Physical Analysis, Thermal, ...1.0153

EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS ...Electrolytes, Pressure, Solution, Sulfate, Sulfite, Ultrasonic Spectroscopy, ...1.0079

Electrochemical

Dielectric Properties

HYDROGEN PROPERTIES ...Density, Fuel Cell-other, Hydrogen, Marine Propulsion, Refraction, ...8.0157

Electrolytes

ELECTROLYTE-NON-ELECTROLYTE INTERACTIONS IN SEA WATER AND RELATED SOLUTIONS ...Alkali Metals, Alkaline Earths, Complexes, Saline Water Systems, Thermal Properties-other, Water Analysis-general, ...1.0107

EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS ...Acoustical, Conductivity, Density, Electrical, Pressure, Sulfate, Sulfite, Viscosity, ...1.0078

EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS ...Conductivity, Pressure, Solution, Sulfate, Sulfite, Ultrasonic Spectroscopy, ...1.0079

Polarization

STEEL PILING ...Corrosion Prevention-other, Fouling, Low Alloy Steels, Soils, Water, ...8.0208

Rheological

Viscosity

EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS ...Acoustical, Conductivity, Density, Electrical, Electrolytes, Pressure, Sulfate, Sulfite, ...1.0078

CHEMICAL PROPERTIES OF SEA WATER AT PRESSURE ...Gases, General Sea Water Chemistry, Interstitial - Connate Water, Pressure, Solubility, ...1.0099

Solution

Solubility

MASS SPECTROMETRIC AND MANOMETRIC STUDIES OF THE OCEANS AND THE ATMOSPHERE ...Chemical Analysis (water), Gases, Mass Spectroscopy, Ocean History, Particle-gas Transfer, ...1.0101

RESEARCH ON THE PHYSICAL CHEMISTRY OF CHEMICAL REACTIONS IN SEA WATER ...Acids, Apatite-general, Carbonate, Bicarbonate, Chemical Reactions, Equilibrium - Chemical, High Pressure Research, Reaction-general, Sulfate, Sulfite, ...1.0127

PRECISION MEASUREMENTS OF DISSOLVED OXYGEN, NITROGEN AND ARGON IN SEAWATER ...Argon, Gases, Nitrogen, Oxygen, Particle-gas Transfer, Special Mission Ships, ...1.0092

SHIPBOARD METHODS OF CHEMICAL ANALYSIS ...Caribbean Sea, Gases, Mass Spectroscopy, Technique Development, Water Analysis-general, ...1.0091

CHEMICAL PROPERTIES OF SEA WATER AT PRESSURE ...Gases, General Sea Water Chemistry, Interstitial - Connate Water, Pressure, Viscosity, ...1.0099

Surface

Bubble

PHYSICAL CHEMISTRY OF BUBBLES ...Diffusion, Interface, Particle-gas Transfer, Surface Energy, ...1.0082

ENVIRONMENTAL REVERBERATION STUDIES ...Acoustical, Electron, Liquids, Reverberation, Scattering, ...1.0039

Monolayers

PROJECT FOG DROPS ...Condensation, Fog-haze-mist, Fog-mist Dissipation, Surfactants, ...3.0090

Surface Energy

PHYSICAL CHEMISTRY OF BUBBLES ...Bubble, Diffusion, Interface, Particle-gas Transfer, ...1.0082

Surfactants

PROJECT FOG DROPS ...Condensation, Fog-haze-mist, Fog-mist Dissipation, Monolayers, ...3.0090

Tension

SURFACE TENSION ...Extraction, Wettability, ...3.0030

Wettability

SURFACE TENSION ...Extraction, Tension, ...3.0030

Chemical Analysis (water)

ECOLOGICAL SURVEY OF EFFLUENT DISCHARGE AT TWO PULP MILLS IN HUMBOLDT COUNTY, CALIFORNIA ...California, Effluents-waste Water, Pollution - Effects of , Pollution Effects, Pulp, Paper , and Logging, ...5.0858

OIL MONITOR INSTRUMENTATION ...Infrared Spectroscopy, Oil, ...8.0093

STUDY OF THE DISTRIBUTION OF RADIONUCLIDES IN THE OCEAN DETAILED EXPLORATION OF CS137 IN THE OCEAN ...Cesium, Circulation-general, Convection, Pacific Ocean-north, Radioactivity, ...1.0080

FLUXES OF DISSOLVED GASES AND NUTRIENTS RELATING TO BIOCHEMICAL AND AERATION PROCESSES OFF THE OREGON COAST ...Gases, Oregon, Organics, Particle-gas Transfer, Phosphate, Phosphite, ...3.0037

DEVELOPMENT OF AN INSTRUMENT FOR MEASURING THE CONCENTRATION OF DISSOLVED OXYGEN IN SEA WATER IN SITU ...Gases, Instrumental Services, Oxygen, Technique Development, Telemetry-other, ...8.0092

MASS SPECTROMETRIC AND MANOMETRIC STUDIES OF THE OCEANS AND THE ATMOSPHERE ...Gases, Mass Spectroscopy, Ocean History, Particle-gas Transfer, Solubility, ...1.0101

DETERMINATION OF VOLATILE ORGANICS IN SEA WATER ...Gas Chromatography, Organics, Organics-general, Technique Development, Water Analysis, ...1.0094

STABLE ISOTOPES ...Atlantic Ocean-north, Atlantic Ocean-south, Carbon, Sampling, Water Chemistry-other, ...1.0108

MARINE RADIOLOGICAL INSTRUMENTATION ...Acoustical, Circulation-general, Laboratory Analysis, Mixing, Radioactivity-general, Sampling, ...8.0062

CHEMICAL CHARACTERISTICS OF THE GREAT LAKES ...Great Lakes-general, Nutrients, Productivity - Food Chain, Water Quality-general, ...1.0116

CHEMICAL ANALYSES ...Chlorinated Hydrocarbons, Estuaries, Substances Or Chemicals, ...6.0149

Chemical Reactions

Condensation

COMPOSITION OF LEAD HALIDE POLLUTION AEROSOLS ...Activation Analysis, Aerosols, Air Pollution Sampling, Air Pollution-chemistry, Oxidation-general, ...6.0156

Decomposition

Biodegradation

HETEROTROPHIC ACTIVITY AND PRIMARY REGENERATION IN THE OCEAN ...Atlantic Ocean-south, Carbon, Gulf of Mexico, Organics, Organics-general, ...1.0114

MICROBIAL CORROSION IN THE MARINE ENVIRONMENT ...Biological, Carbon, Fouling, Marine Fungi (non-specific), Water, ...5.0769

Decomposition-other

NATURAL COMPOUNDS WITH CARBON-PHOSPHORUS BONDS ...Anthozoa, Bond Type, Natural Occurring, Phosphorous, ...5.1013

Electrochemical

Electrode

CHEMICAL METHODOLOGY - APPLICATIONS OF NITRATE SPECIFIC ELECTRODE TO CHEMICAL OCEANOGRAPHY ...Water Analysis-general, ...1.0093

Interfacial

PHASE RELATIONS OF THE HYDRATED CARBONATES OF CALCIUM AND MAGNESIUM ...Carbonate, Bicarbonate, Equilibrium - Chemical, Phase Relationships, Properties and Structure, Surface Chemistry, ...3.0085

Oxidation

Oxidants

HYDROGEN-OXYGEN FUEL CELLS ...Encapsulation, Fuel Cell-other, Gas Generator, Safety, Submersibles, ...8.0160

Oxidation-general

COMPOSITION OF LEAD HALIDE POLLUTION AEROSOLS ...Activation Analysis, Aerosols, Air Pollution Sampling, Air Pollution-chemistry, Condensation, ...6.0156

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CATALYSIS AND KINETICS OF MANGANOUS ION OXIDATION IN AQUEOUS SOLUTION AND ADSORBED ON THE SURFACES OF SOLID OXIDES ...Adsorption, Heterogeneous Catalysis, Manganese, Oxide, Precipitates, Solution, ...2.0063

Photochemical

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POLYPEPTIDE INTERACTIONS ON A STERILE SEASHORE ...Biochemical, Melanin, Origin of Life, Polypeptides, ...5.0942

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EXCITED STATES MECHANISMS IN PHOTOBIOLOGY ...Bioluminescence, Chemiluminescence, Energy Conversion, Polypeptides, ...4.0162

Reaction-general

CHEMICAL OCEANOGRAPHY ...Carbon, Carbon-14, Chemical Reactions, Gulf of Mexico, Organics, ...1.0131

RESEARCH ON THE PHYSICAL CHEMISTRY OF CHEMICAL REACTIONS IN SEA WATER ...Acids, Apatite-general, Carbonate, Bicarbonate, Chemical Reactions, Equilibrium - Chemical, High Pressure Research, Solubility, Sulfate, Sulfite, ...1.0127

SOLUTION-SILICATE REACTIONS AND EQUILIBRIA ...Chemical Reactions, Chemistry, Equilibrium - Chemical, Groundwater, Silicate-general, Solution, Solution Chemistry, ...1.0097

Synthesis

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CELL DIVISION, BIOENERGETICS, CHEMISTRY OF MUSCLE ...Bioenergetics, Cell Cycle, Configuration, Glyoxal, ...5.0987

CHEMISTRY AND PHARMACOLOGY OF TETRODOTOXIN ...Poisons-other, Toxicology, ...6.0105

Chemical Separation

Filtration

OIL - WATER SEPARATOR ...Oil, Separation-flow-other, ...8.0124

Isotope

GEOCHEMICAL STUDIES OF CONTINENTAL WATERS ...Authigenesis, Element Ratios, Geochemical Analysis, Isotope Tracer-other, Location, Pore Fluids, Radioisotopes, Water Analysis, ...1.0121

RADIOELEMENT STUDIES IN THE OCEANS - GEOLOGY AND GEOCHEMISTRY ABOUT THE MID-ATLANTIC RIDGE ...Adsorption Capacity, Chemistry, Removal--inorganics, Ridges, Water Analysis, ...7.0072

Precipitation

SEDIMENTARY GEOCHEMISTRY ...Authigenesis, Other, Removal--inorganics, Water Chemistry-other, ...7.0190

GEOCHEMISTRY OF CARBONATE CYCLE IN THE MARINE ENVIRONMENT ...Calcium, Carbonate, Bicarbonate, Chemical Reactions, Optical, Removal--inorganics, ...7.0069

Chemistry - Coordination

Chelating Agents

TRACE ELEMENT EQUILIBRIUM STUDIES ...Adsorption, Ion Exchange, Material Recovery, Trace Elements, Tracers, ...1.0088

EFFECTS OF CRUDE OILS AND THEIR EMULSIONS TO MARINE ORGANISMS ...Emulsion, Oil, Oil and Natural Gas - Sulfur, Poisons-other, Removal--organics, ...5.0924

Complexes

ELECTROLYTE-NON-ELECTROLYTE INTERACTIONS IN SEA WATER AND RELATED SOLUTIONS ...Alkali Metals, Alkaline Earths, Electrolytes, Saline Water Systems, Thermal Properties-other, Water Analysis-general, ...1.0107

Chemistry - Effects

Additives

TURBULENCE STRUCTURE AND NOISE STUDY ...Noise, Turbulent, ...1.0002

Pressure

EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS ...Conductivity, Electrolytes, Solution, Sulfate, Sulfite, Ultrasonic Spectroscopy, ...1.0079

ENERGY CONVERSION MATERIALS AND COMPONENTS ...Durability, Deterioration, Electrode, Fuel Cell-other, Hydrazine, Hydrocarbon, ...8.0223

Radiation

STABILITY OF FOOD LIPIDS TO IONIZING RADIATION ...Fats, ...**6.0029**

Chemistry - Mechanisms

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CATALYSIS AND KINETICS OF MANGANOUS ION OXIDATION IN AQUEOUS SOLUTION AND ADSORBED ON THE SURFACES OF SOLID OXIDES ...Adsorption, Heterogeneous Catalysis, Manganese, Oxidation-other, Oxide, Precipitates, ...**2.0063**

SOLUTION-SILICATE REACTIONS AND EQUILIBRIA ...Chemical Reactions, Chemistry, Equilibrium - Chemical, Groundwater, Reaction-general, Silicate-general, Solution Chemistry, ...**1.0097**

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GEOCHEMICAL OCEANOGRAPHY ...Carbonaceous Substance, Organic, Organics, ...**1.0102**

EFFECT OF NITRILOTRIACETIC ACID (NTA) UPON THE TOXICITY OF METALS TO SELECTED SPECIES OF ESTUARINE PHYTOPLANKTON ...Carbon, Chemicals (incl. algacides), Estuaries, Isotope Tracer-other, Phytoplankton, ...**5.0829**

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NATURAL COMPOUNDS WITH CARBON-PHOSPHORUS BONDS ...Anthozoa, Bond Type, Decomposition-other, Natural Occurring, ...**5.1013**

Dyes and Coloring

APPLICATION OF ISCC-NBS CENTROID COLORS AND METHOD OF DESIGNATION COLORS ...Colorimetry, Paint - General, Photography-chemistry, Pigments, Standards, Specifications, ...**4.0097**

Organics-general

HETEROTROPHIC ACTIVITY AND PRIMARY REGENERATION IN THE OCEAN ...Atlantic Ocean-south, Biodegradation, Carbon, Gulf of Mexico, Organics, ...**1.0114**

A SYMPOSIUM ENTITLED ORGANIC CHEMISTRY OF NATURAL WATERS ...Alaska, Chemical-general, Meetings, Organic, Organic Matter, Organic-general, Organics, Polar, Sediments, Water Analysis, Water Chemistry, ...**11.0001**

DETERMINATION OF VOLATILE ORGANICS IN SEA WATER ...Chemical Analysis (water), Gas Chromatography, Organics, Technique Development, Water Analysis, ...**1.0094**

Organometallics

FOULING OF SENSORS ...Fouling, Inhibitors, Instrumentation-general, Marine Biology, ...**8.0239**

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EFFECTS OF CRUDE OILS AND THEIR EMULSIONS TO MARINE ORGANISMS ...Chelating Agents, Emulsion, Oil, Oil and Natural Gas - Sulfur, Removal--organics, ...**5.0924**

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Chemistry - Polymer

Morphology

VISCOSITY AND VISCOELASTICITY OF LIQUIDS AND GLASSES ...Glass, Instrumental Services, Liquid, State Variables - Pvt, Viscoelasticity, Viscosity, ...**8.0260**

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PROCESS ENGINEERING ...Design, Machinery, Equipment, Esters, Extraction, Fats and Oils -other, Fish Protein Concentrate, Industrial Operation, Legal Standards, ...**6.0080**

NATURAL COMPOUNDS WITH CARBON-PHOSPHORUS BONDS ...Anthozoa, Bond Type, Decomposition-other, Phosphorous, ...**5.1013**

Organometallic

DIELECTRIC MATERIALS ...Dielectric Materials, Submersibles, Thermal Properties, ...**8.0215**

Chemistry - Surface & Colloid

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THE CYCLE OF ORGANIC MATTER IN THE DEEP SEA ...Abyssal, Biogenous, Distribution, Marine Bacteria, Origin, ...**1.0112**

CATALYSIS AND KINETICS OF MANGANOUS ION OXIDATION IN AQUEOUS SOLUTION AND ADSORBED ON THE SURFACES OF SOLID OXIDES ...Heterogeneous Catalysis, Manganese, Oxidation-other, Oxide, Precipitates, Solution, ...**2.0063**

TRACE ELEMENT EQUILIBRIUM STUDIES ...Chelating Agents, Ion Exchange, Material Recovery, Trace Elements, Tracers, ...**1.0088**

DISTRIBUTION OF ELEMENTS IN FLUVIAL AND BRACKISH ENVIRONMENTS ...Adsorption Capacity, Brackish Water, Chemical Reactions, Element Ratios, Exchange Capacity, Solution, ...**7.0221**

SEDIMENT MINERALOGY (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Chemistry, Food Webs, Productivity - Food Chain, Radioactivity, Radioactivity-general, ...**7.0077**

Catalysts

EVALUATION OF BOOTTOP PAINT SYSTEMS FOR OCEAN-GOING SHIPS IN A BOOTTOP PAINT TESTING MACHINE ...Paint - General, Primers, Surface Cleaning, Finishing, Test Methods, Water, ...**8.0237**

Condensation

PROJECT FOG DROPS ...Fog-haze-mist, Fog-mist Dissipation, Monolayers, Surfactants, ...**3.0090**

Electrokinetics

Electroosmosis

CRITICAL TABLES ON THE ELECTROCHEMICAL PROPERTIES OF INTERFACES ...Electrophoresis, Streaming Potential, Zeta Potential, ...**1.0140**

ELECTROKINETIC SOIL STUDY ...Buried Structures, Electroosmosis, Electrophoresis, Laboratory Analysis, Marine Soils, Stabilization, ...**8.0342**

Electrophoresis

CRITICAL TABLES ON THE ELECTROCHEMICAL PROPERTIES OF INTERFACES ...Electroosmosis, Streaming Potential, Zeta Potential, ...**1.0140**

ELECTROKINETIC SOIL STUDY ...Buried Structures, Electroosmosis, Electroosmosis, Laboratory Analysis, Marine Soils, Stabilization, ...**8.0342**

Streaming Potential

CRITICAL TABLES ON THE ELECTROCHEMICAL PROPERTIES OF INTERFACES ...Electroosmosis, Electrophoresis, Zeta Potential, ...**1.0140**

Zeta Potential

CRITICAL TABLES ON THE ELECTROCHEMICAL PROPERTIES OF INTERFACES ...Electroosmosis, Electrophoresis, Streaming Potential, ...**1.0140**

MEASUREMENT OF SURFACE CHARGE ON PARTICLES SUSPENDED IN SEA WATER ...Electrical, Suspension, Water Chemistry-other, ...**7.0205**

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EFFECTS OF CRUDE OILS AND THEIR EMULSIONS TO MARINE ORGANISMS ...Chelating Agents, Oil, Oil and Natural Gas - Sulfur, Poisons-other, Removal--organics, ...5.0924

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CATALYSIS AND KINETICS OF MANGANOUS ION OXIDATION IN AQUEOUS SOLUTION AND ADSORBED ON THE SURFACES OF SOLID OXIDES ...Adsorption, Manganese, Oxidation-other, Oxide, Precipitates, Solution, ...2.0063

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THE MARINE ALGAE OF VIRGINIA ...Algae- General, Benthonic-bottom, Marine Plants, Plant Taxonomy, Virginia, ...5.0698

THE BIOLOGY AND CHEMISTRY OF TRACE ELEMENTS IN MARINE AND ESTUARINE WATERS ...Estuaries, Phytoplankton, Productivity - Food Chain, Trace Element Analysis, Zooplankton, ...5.0975

OCEAN KINEMATICS DYNAMICS ...Circulation-general, Data Reduction and Analysis, Estuaries, Turbulent Flow, Water Motion, ...2.0069

TURBULENT DIFFUSION STUDY ...Dispersion -water, Estuaries, Tracers-general, Turbulent Flow, Water Motion, ...2.0056

ESTIMATION OF PARAMETERS OF STRIPED BASS POPULATION AND DESCRIPTION OF THE FISHERY OF LOWER CHESAPEAKE BAY ...Age, Basses -sea,white, White Perch, Censusing, Fishing Gear, Population Dynamics, ...5.0151

THE DETERMINATION OF THE AVAILABILITY OF SEA ROBINS ...Benthic Fauna, Fish -other, Nets, Vertical Distribution, ...5.0152

REGIONAL DEMAND IN THE U.S. AND TRENDS IN THE FISHING AND SEAFOOD PROCESSING INDUSTRIES OF THE CHESAPEAKE BAY AREA ...Commercial Fishing, Consumer Pref. & Consumption, Consumption, Fish & Shellfish, Fish -non-specific, Market Structure, ...6.0028

ENHANCEMENT OF RECREATIONAL USES OF ESTUARINE WATERS THROUGH STUDY OF POTENTIAL CONTROL METHODS FOR STINGING SEA NETTLES ...Biological Control, Estuaries, Jelly Fish, Recreation Sites, Water Quality-general, ...5.0605

ALGAE AS FOOD FOR MARINE INVERTEBRATE LARVAE HELD IN THE LABORATORY ...Algal Culture, Bulk Culture -other, Invertebrate Nutrition, Invertebrates -non-specific, ...5.0732

OCEANOGRAPHIC SURVEY OF CONTINENTAL SHELF WATERS OFF CHESAPEAKE BAY ...Continental Shelf, Marine Biology, Salinity, Temperature, ...4.0135

DISTRIBUTION, AGE GROWTH, AND MORTALITY STUDIES OF SALT WATER FISHES OF IMPORTANCE TO SPORT FISHERMEN ...Age, Drums, Growth Rate, Mortality Rates, Vertical Distribution, ...5.0155

INFAUNA OF LOWER CHESAPEAKE BAY ...Aquatic Ecology, Population Dynamics, Shrimp - Amphipods, Streams, Virginia, ...5.0661

ANALYSIS OF AN ATTEMPT TO CONTROL BEACH EROSION AT SCIENTISTS CLIFFS, MARYLAND ...Beaches, Engineering Studies-other, Erosion, Groin, Maryland, ...8.0038

EFFECTS OF HEATED WATER IN A TIDAL ESTUARY ...Electric Power Plants, Pollution - Effects of , Pollution Effects, Thermal Pollution, Tidal Streams, Water Properties-general, ...6.0145

PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE UPPER CHESAPEAKE BAY ...Chemical-general, Crustacea -non-specific, Environmental Ecology, Mollusks -non-specific & Other, Physical-general, ...1.0150

POTENTIAL OYSTER SETTING CAPACITY - LOCAL AREAS ...Commercial Fishing, Mark, Tag Or Capture -other, Oysters, Spawning & Nesting Sites, Streams, ...5.0445

Chile

A PROGRAM FOR THE TRAINING OF STAFF MEMBERS FROM THE SCHOOL OF FISHERIES OF THE CATHOLIC UNIVERSITY OF VALPARAISO CHILE ...Fish -non-specific, Food Processing Industry, Marine Biology, Teaching and Research, ...5.0181

Chloride

SIGNIFICANCE OF FLUORIDE VARIATIONS IN SEA WATER ...Atlantic Ocean-general, Element Ratios, Extrusives, Fluoride, Water Analysis-general, ...1.0105

Chlorophyll

BIOLOGY AND CHEMISTRY OF MARINE PLANKTON POPULATIONS ...Buoys, Phytoplankton, Vertical Distribution, Zooplankton, ...5.0798

Chromatography

Gas Chromatography

DETERMINATION OF VOLATILE ORGANICS IN SEA WATER ...Chemical Analysis (water), Organics, Organics-general, Technique Development, Water Analysis, ...1.0094

RED TIDE TOXICITY ...Algal Toxins, Biochemical Analysis, Gymnodinium, Plant Developmental Biology, Pollution Sources-other, ...5.0780

PESTICIDE MONITORING PROGRAM ...Bioindicators, Estuaries, Monitoring Systems, Oysters, Persistance of Residues, ...6.0147

Ion Exchange

ANALYSIS OF SEA WATER BY DIFFERENCE CHROMATOGRAPHY ...Interstitial - Connate Water, Runoff, Salinity, Water Analysis-general, ...1.0110

Paper Chromatography

NUTRITIVE VALUE OF FISH AND OTHER MARINE PRODUCTS ...Ascorbic Acid, Fish -non-specific, Nutritive Value, Proteins -non-specific, Thiamine, ...6.0054

Circulation -water

FLUSHING PATTERN OF CERTAIN TIDAL STREAMS IN DELAWARE ...Aquatic Ecology, Delaware, Discharge, Industrial-general, Tidal Streams, ...2.0013

HORIZONTAL DISPERSION IN SHALLOW ESTUARIES OF IRREGULAR SHAPE ...Dispersion -water, Estuaries, Gulf of Mexico, Model Studies, Water Quality-general, ...2.0064

BIG EDDIES AND MIXING PROCESSES IN THE GREAT LAKES ...Dispersion -water, Effluents-waste Water, Great Lakes-general, Mixing, Water Motion, ...2.0052

AN ENVIRONMENTAL SURVEY OF THE DAMARISCOTTA RIVER ESTUARY, LINCOLN COUNTY, MAINE ...Estuaries, Nutrients, Pollution - Effects of , Salinity, Sedimentology-general, ...5.0895

Circulation-general

AIR-SEA INTERACTION PROCESS ...Boundary Layer Studies, Buoys, Lakes, Profiles, Wind-water Interaction, ...3.0028

STUDY OF THE DISTRIBUTION OF RADIONUCLIDES IN THE OCEAN DETAILED EXPLORATION OF CS137 IN THE OCEAN ...Cesium, Chemical Analysis (water), Convection, Pacific Ocean-north, Radioactivity, ...1.0080

PHYSICAL AND BIOLOGICAL OCEANOGRAPHY OF A LUMINOUS BAY ...Bays, Bioluminescence, Jamaica, Model Studies, Phytoplankton, ...5.0976

TIME DEPENDENT VARIATIONS IN SURFACE OCEANIC CIRCULATION ...Ocean History, Pollution Sources-general, Sedimentary History, Temperature, Waste Disposal-general, ...2.0038

OCEAN CIRCULATION AND CONTROLLING FACTORS FOR PREDICTION ...Meteorological Studies, Oceanic Fronts, Salinity, Temperature, ...**2.0034**

HAWAIIAN OCEANOGRAPHY ...Environmental Effects-geologic, Hawaii, Hydrodynamics, Islands, Ocean Currents-other, ...**2.0021**

CHEMICAL OCEANOGRAPHY ...Biogeochemical Process, Geologic, Organics, Rare Earth Studies, Trace Elements, ...**1.0129**

OCEAN KINEMATICS DYNAMICS ...Chesapeake Bay, Data Reduction and Analysis, Estuaries, Turbulent Flow, Water Motion, ...**2.0069**

CIRCULATION STUDIES ...Currents-ocean, Gulf of Mexico, Hydrodynamics, Mixing, Pacific Ocean-east, ...**2.0042**

NORTH ATLANTIC CIRCULATION ...Atlantic Ocean-north, Geomorphology-topography, Gulf Stream, Hydrodynamics, Oceanic Fronts, ...**2.0031**

LIGHT ISOTOPE STUDIES ...Chemical Reactions, Deuterium, Isotope Tracer-other, Mixing, Oxygen, Particle-gas Transfer, ...**1.0077**

CIRCULATION OF THE PACIFIC ...Density, Oceanic Fronts, Pacific Ocean-general, Sampling, Subsurface Environments, ...**2.0007**

DESCRIPTIVE OCEANOGRAPHY ...Currents-ocean, Data Analysis - General, Pacific Ocean-east, Wind-water Interaction, ...**4.0116**

LANGMUIR CIRCULATION AND PLANKTON ECOLOGY ...Phytoplankton, Range Or Territorial Distr. , Vertical Distribution, Water Movement, Currents,, Wind Or Air Movement, Zooplankton, ...**5.0794**

AIR-SEA INTERACTION AND PLANKTON ECOLOGY ...Environmental Ecology, Marine Biology (non-specific), Number Or Density, Plankton (non-specific), ...**4.0078**

THE CONTRIBUTION OF ADVECTION AND LOCAL HEATING TO THE MAINTENANCE OF THE THERMAL STRUCTURE IN THE NORTH PACIFIC OCEAN ...Convection, Heat and Radiation Transfer, Mixing, Pacific Ocean-north, Thermal, ...**1.0183**

MARINE HYDRODYNAMICS ...Antarctic Ocean, Laboratory Analysis, Model Studies, Waves, Waves-internal, ...**8.0196**

DYNAMICAL OCEANOGRAPHY AND GEOPHYSICAL FLUID DYNAMICS ...Acoustic Effects, Forced Convection, Theoretical Analysis, Thermal, Water Tunnels Tables, ...**2.0012**

STUDIES IN THE INDIAN OCEAN ...Data Analysis - General, Indian Ocean-general, Particle-gas Transfer, Storms-general, ...**2.0073**

CIRCULATION AROUND OCEANIC ISLANDS ...Density, Islands, Mixing, Thermodynamics, Waves-internal, Wind-water Interaction, ...**2.0010**

INVESTIGATION OF SHALLOW CURRENT STRUCTURE IN THE WESTERN TROPICAL ATLANTIC OCEAN ...Atlantic Ocean-general, Temperature, Tropic, ...**2.0030**

CHEMICAL FEATURES OF THE SUBARCTIC BOUNDARY IN THE NORTHERN PACIFIC OCEAN ...Carbon Dioxide, Gases, Mixing, Oceanic Fronts, Pacific Ocean-north, Sub - Polar, ...**1.0125**

STUDY OF INFLUENCE OF STRATIFICATION ON CURRENT STRUCTURE ...Currents-other, Hydrodynamics, Lake Michigan, Stratified Flow, ...**2.0035**

STUDY OF DEEP PACIFIC CIRCULATION USING SILICON-32 ...Carbon, General Sea Water Chemistry, Pacific Ocean-general, Silicon, Tracers, ...**2.0006**

HEAVY METAL GEOCHEMISTRY OF ANTARCTIC SEA WATER AND MARINE SEDIMENTS ...Antarctic Ocean, Chemistry, Sedimentation, Water Analysis-general, ...**1.0086**

THEORY OF LARGE-SCALE ATMOSPHERIC AND OCEANIC PROCESSES ...Currents-ocean, Model Studies, Tropic, Weather Forecasting, Wind-water Interaction, ...**2.0070**

ESTUARINE SEDIMENTARY MODELS ...Distribution, Estuaries, Grain Size, Model Studies, Textures-structures, ...**4.0079**

CURRENTS AND WATER MASSES IN THE SOUTHWEST ATLANTIC ...Currents-ocean, Oceanic Fronts, Subsurface Environments, ...**2.0041**

(U) OCEAN CIRCULATION MODELS ...Currents-ocean, Model Studies, Shear, Waves, Wind-water Interaction, ...**2.0024**

CIRCULATION IN THE GULF OF MEXICO ...Currents-ocean, Gulf of Mexico, Infrared Radiation, Mapping, Oceanic Fronts, ...**2.0022**

THEORETICAL AND LABORATORY MODEL STUDIES OF LARGE-SCALE OCEAN CIRCULATION ...Currents-ocean, Forecasting-prediction, Gulf Stream, Model Studies, Transducers, ...**2.0023**

FINE STRUCTURE FEATURES OF TEMPERATURE AND SALINITY AT WATER MASS BOUNDARIES IN PACIFIC ...Mixing, Oceanic Fronts, Pacific Ocean-north, Salinity, Temperature, ...**2.0046**

CHEMICAL OCEANOGRAPHY ...Arctic, Isotope Tracer-other, Oceanic Fronts, Tracers, Water Analysis-general, ...**1.0072**

WATER MASS TRACERS ...Acoustical, Currents-ocean, Oceanic Fronts, Tracers, ...**2.0020**

VERTICAL OCEAN CIRCULATION ...Convection, Model Studies, Oceanic Fronts, Subsurface Environments, ...**2.0036**

DESCRIPTIVE OCEANOGRAPHY/PACIFIC ...Buoys, Currents-ocean, Pacific Ocean-east, Wind-water Interaction, ...**2.0009**

CIRCULATION STUDIES ...Currents-ocean, Gulf of Mexico, Model Studies, Thermal, Tropical Cyclones, ...**2.0044**

MARINE RADIOLOGICAL INSTRUMENTATION ...Acoustical, Chemical Analysis (water), Laboratory Analysis, Mixing, Radioactivity-general, Sampling, ...**8.0062**

OCEAN CIRCULATION ...California Current, Forecasting-prediction, Hydrodynamics, Model Studies, Submarine Canyons, ...**2.0002**

INVESTIGATION OF THE CIRCULATION OF LAKE SUPERIOR ...Lake Superior, Model Studies, Stratified Flow, Temperature, Thermodynamics, Water Motion, ...**2.0048**

RESIDENCE TIMES OF WATERS BEHIND BARRIER ISLANDS ...Bays, Simulation Theory, Tides, Wind-water Interaction, ...**2.0018**

VERTICAL CURRENT STRUCTURE IN THE GREAT LAKES ...Great Lakes-general, Temperature, ...**2.0033**

FEASIBILITY OF THE APPLICATION OF PALYNOLOGICAL INVESTIGATION OF DEEP-SEA SEDIMENTS TO MAJOR GEOLOGICAL PROBLEMS ...Biology, Paleoclimatology, Pollen, Pollens, Spores, ...**7.0206**

CHRONOLOGY OF MARINE SEDIMENTS, CIRCULATION OF WATER AND TRACE ELEMENTS, SEDIMENTARY RECORD AND EXTRATERRESTRIAL ACCRETION ...Cosmogenous, Pacific Ocean-general, Paleoclimatology, Sedimentary History, Trace Elements, ...**1.0098**

RADIOSTRONTIUM DEPOSITION OVER THE OCEAN ...Nuclear Explosions - Fallout, Precipitation-general, Radioactive Dating, Radioactivity, Strontium, ...**6.0165**

RADIOISOTOPE TRACERS IN OCEANOGRAPHIC RESEARCH ...Radioactivity-general, Sampling, Trace Elements, Tracers, ...**2.0001**

OCEAN CURRENTS AND CIRCULATION ...Currents-ocean, Data Acquisition, Energy, Model Studies, Temperature, ...**2.0015**

STUDY OF EFFECTS OF OFFSHORE DUMPING ...Dispersion - water, Engineering Studies-other, Pollution - Effects of , Pollution Sources-other, Shoreline - Coastline, ...**6.0144**

HISTORICAL CHARTS AND INTERPRETATION OF CHANGES IN SEA SURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN ...Air-sea Boundary-general, Atlases-maps, Commercial Fishing, Pacific Ocean-north, Temperature, ...**1.0179**

CHEMICAL OCEANOGRAPHY ...Aquatic Ecology, Convection, Technique Development, Trace Elements, ...**1.0134**

CIRCULATION DYNAMICS (GULF OCEANOGRAPHY PROGRAM) ...Environmental Changes, Gulf of Mexico, Shrimps - Common, Thermodynamics, ...**2.0045**

SEA SURFACE SURVEILLANCE ...Caribbean Sea, Temporal Distribution, Tuna, Mackerel, Albacore... , Vertical Distribution, Water Properties-general, ...**2.0019**

FISHERY FORECASTING - TEMPERATE FISHERIES ...General Synoptic Observations, Low Temp. -but Above 32f, Pacific Ocean-east, Temperature, ...**5.0197**

DISPOSAL TO MARINE WATERS ...Model Studies, Monitoring (long Term Studies), Pollution - Effects of , Pollution Sources-general, Shoreline - Coastline, ...**6.0177**

WESTERN ARCTIC OCEANOGRAPHIC INVESTIGATIONS ...Arctic, Arctic Ocean, Basins, Mixing, ...**2.0014**

ICEBERG DRIFT AND DETERIORATION ...Icebergs, Model Studies, Ocean Currents-other, ...**3.0076**

OCEANOGRAPHY OF THE GRAND BANKS AND LABRADOR SEA ...Buoys, Icebergs, Labrador Current, Labrador Sea, Meteorological Studies, ...**4.0124**

ARCTIC EAST OCEANOGRAPHIC PROJECT (OCEANOGRAPHY OF THE BAFFIN BAY REGION) ...Baffin Bay, Marine Biology, Polar, Sea Water Chemistry-other, Water Properties-general, ...**4.0125**

CIRCULATION ON THE CONTINENTAL SHELF ...Atlantic Ocean-north, Continental Shelf, Eastern, Water Motion Recorders, ...2.0027

Classifications

CONTRACT FOR-PROCESSING OF USARP ROCK SAMPLES ...Antarctica, Collections, Coring and Dredging, Petrology, Sampling, Ships and Cruises, Thin Sections, ...7.0060

Climatic Regions

Arid and Desert

SUPPORT OF THE VERMILION SEA FIELD STATION AT BAHIA DE LOS ANGELES, BAJA CALIFORNIA ...Facilities, Gulf of California, Habitat Studies, Temperature, Tides, ...12.0009

GULF OF CALIFORNIA BIOLOGY ...Bioluminescence, Gulf of California, Intertidal Areas, Population Dynamics, Tropic, ...5.0856

A UNIFIED APPROACH TO WATER, FOOD AND POWER IN A COASTAL DESERT COMMUNITY ...Desalination, Deserts, Diesel. Distilling Units, Electric Power Plants, Greenhouse, Use of Impaired Water, ...7.0002

Microclimate-general

PHYSIOLOGY AND ECOLOGY OF THE ADRIATIC BENTHOS ...Adriatic Sea, Benthic Organisms (non-specif), Marine Biology (non-specific), Metabolism, Productivity - Food Chain, ...5.0873

Polar

MARINE BIOLOGY IN ALASKA ...Alaska, Amino Acids -non-specific, Porifera, Trenches, ...5.0854

A SYMPOSIUM ENTITLED ORGANIC CHEMISTRY OF NATURAL WATERS ...Alaska, Chemical-general, Meetings, Organic, Organic Matter, Organic-general, Organics, Organics-general, Sediments, Water Analysis, Water Chemistry, ...11.0001

PHYSIOLOGICAL STUDIES ON FISHES LACKING HEMOGLOBIN ...Adaptation, Cardiovascular System, Fish, Fish -other, Hemoglobin, Metabolism, ...5.0241

SEDIMENTS IN BAFFIN BAY AND THE EFFECTS OF AN ARCTIC ENVIRONMENT ON MARINE SEDIMENTATION ...Baffin Bay, Benthonic-bottom, Origin, Physical Properties, Sedimentation, ...7.0265

SEA ICE MOVEMENT DYNAMICS ...Charts, Forecasting-prediction, Mapping, Model Studies, Sea Ice, ...3.0087

CANADIAN ARCTIC AND SUBARCTIC POLYCHAETES COLLECTED BY E. H. GRAINGER ...Animal Taxonomy, Collections, Lugworms, Marine Segmentedworm, Sub - Polar, ...5.0576

ENVIRONMENTAL MEASURING EQUIPMENT ...Meteorological Studies, Platforms, ...4.0007

ARCTIC EAST OCEANOGRAPHIC PROJECT (OCEANOGRAPHY OF THE BAFFIN BAY REGION) ...Baffin Bay, Circulation-general, Marine Biology, Sea Water Chemistry-other, Water Properties-general, ...4.0125

Sub - Polar

CHEMICAL FEATURES OF THE SUBARCTIC BOUNDARY IN THE NORTHERN PACIFIC OCEAN ...Carbon Dioxide, Circulation-general, Gases, Mixing, Oceanic Fronts, Pacific Ocean-north, ...1.0125

CANADIAN ARCTIC AND SUBARCTIC POLYCHAETES COLLECTED BY E. H. GRAINGER ...Animal Taxonomy, Collections, Lugworms, Marine Segmentedworm, Polar, ...5.0576

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STUDIES WITH TROPICAL AND SUBTROPICAL MICROALGAE ...Algal Culture, Benthic Flora, Continental Shelf, Primary Productivity, Tropic, ...5.0693

ECOLOGY OF PHYTOPLANKTON IN SEMI-TROPICAL ENVIRONMENTS ...Caribbean Sea, Phytoplankton, Range Or Territorial Distr. , Temporal Distribution, Vertical Distribution, ...5.0778

MORPHOLOGY AND TAXONOMY OF MARINE FUNGI ...Habitat Studies, Mangroves, Marine Fungi (non-specific), Plant Morphology, Plant Taxonomy, Tropic, ...5.0716

CHANGES IN THE LIMITING NUTRIENT DUE TO TEMPORAL, GEOGRAPHIC, AND DEPTH VARIATIONS ...Depth, New York, Nutrients, Phytoplankton, Water Depth, Water Levels, ...5.1004

Temperate

TAXONOMIC REVISION OF BATHYLAGIDAE ...Animal Taxonomy, Deepsea Smelts, Tables, Compilations, Catalogs, Tropic, ...5.0055

Tropic

TROPICAL STORM INVESTIGATIONS IN THE ATLANTIC, CARIBBEAN, AND GULF OF MEXICO ...Meteorological Studies, Satellites, Tropical Cyclones, Vorticity, Waves, ...3.0048

DYNAMIC STUDY OF THE TEMPORAL ...Air Motion-general, Meteorologic Model Studies, Satellites, Storms-general, Tropical Cyclones, ...3.0051

TROPOSHERE METEOROLOGY IN THE TROPICAL ATLANTIC AREA ...Anticyclones-cyclones, Atlantic Ocean-general, Clouds-precipitation, Meteorological Studies, Patterns, ...3.0049

MESO AND CONVECTIVE SCALE SYSTEMS IN THE MARITIME TROPICAL ATMOSPHERE ...Air Motion-general, Convection, Heat Budget, Islands, Meteorologic Model Studies, ...3.0062

EQUATORIAL CIRCULATIONS IN THE STRATOSPHERE ...Atmospheric Divisions, Mass Transport, Ocean-lakes, Patterns, ...3.0066

STUDIES WITH TROPICAL AND SUBTROPICAL MICROALGAE ...Algal Culture, Benthic Flora, Continental Shelf, Primary Productivity, Sub - Tropic, ...5.0693

ECOLOGY OF TROPICAL DEEP WATER ALGAE ...Algae-General, Benthic Flora, Diving and Scuba, Plant Succession, Temporal Distribution, Vertical Distribution, ...5.0722

SUPPORT FOR THE PHYSIOLOGICAL RESEARCH SHIP, R/V ALPHA HELIX ...Insecticides -non-specific, Mycorrhiza, Nerve Effects, Rain Forests, Regulation, ...12.0011

ECOLOGICAL STUDIES OF THE SOUTHEASTERN FLORIDA SEA GRASS COMMUNITY - PRIMARY PRODUCTION BY THALASSIA TESTUDINUM KONIG ...Elodea, Waterweed, Thalassia, Florida, Primary Productivity, Submerged Plants, Translocation, ...5.0695

STUDIES OF THE EFFECTS OF NUTRIENTS ON THE GROWTH OF PHYTOPLANKTON IN THE TROPICAL PAC. OCEAN ...Algal Culture, Growth Rate, Nutrition, Pacific Ocean-general, Phytoplankton, ...5.0948

MORPHOLOGY AND TAXONOMY OF MARINE FUNGI ...Habitat Studies, Mangroves, Marine Fungi (non-specific), Plant Morphology, Plant Taxonomy, Sub - Tropic, ...5.0716

BIOLOGY OF THE DEEP-SEA BENTHOS ...Atlantic Ocean-general, Benthic Fauna, Number Or Density, Vertical Distribution, ...5.0902

OCEANIC FISHES OF THE TROPICAL ATLANTIC ...Atlantic Ocean-south, Fish -non-specific, Survey Studies, Vertical Distribution, ...5.0068

DIVERSITY, COMMUNITY STRUCTURE AND TROPHIC RELATIONS OF TROPICAL ZOOPLANKTON ...Bays, Interbiotic Relat.(non-specif), Productivity - Food Chain, Zooplankton, ...5.0785

GENERAL SYSTEMATIC STUDIES OF THE OCTOCORALLIA OF THE TROPICAL ATLANTIC ...Animal Taxonomy, Anthozoa, ...5.0589

ATMOSPHERIC PROCESSES IN THE TROPICS ...Data Reduction and Analysis, Patterns, Shear, Statistics-general, Tropical Cyclones, ...3.0059

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THEORY OF LARGE-SCALE ATMOSPHERIC AND OCEANIC PROCESSES ...Circulation-general, Currents-ocean, Model Studies, Weather Forecasting, Wind-water Interaction, ...2.0070

ATMOSPHERIC EFFECTS ON INCOMING SOLAR RADIATION OVER TROPICAL OCEANS ...Cloud Cover, Development of Models, Humidity, Pacific Ocean-general, Sunshine, ...3.0036

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GULF OF CALIFORNIA BIOLOGY ...Arid and Desert, Bioluminescence, Gulf of California, Intertidal Areas, Population Dynamics, ...5.0856

COASTAL MORPHOLOGY ...Beach, Deltas, Development, General Information Services, Shore Features-general, Shoreline - Coastline, ...7.0297

ECOLOGICAL STUDIES ON TROPICAL INTERTIDAL BRITTLESTARS ...Brittle Stars, Habitat Studies, ...5.0615

OBJECTIVE WEATHER ANALYSIS ...Research - Development, Technique Development, Weather Forecasting, Wind-general, ...4.0042

TROPICAL ANALYSIS AND FORECASTING ...Filtering Theory, Mathematical Analysis, Meteorologic Model Studies, Pressure-density, Weather Forecasting, ...3.0061

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STUDIES OF FISH FAMILIES ARIIDAE AND ASPREDINIDAE ...Animal Taxonomy, Fish -other, Interbiotic Relat.(non-specif), Neotropical, ...5.0052

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ZOOPLANKTON DISTRIBUTION IN THE TROPICAL ATLANTIC ...Atlantic Ocean-general, Plankton Sampling, Range Or Territorial Distr. , Temperature, Vertical Distribution, Zooplankton, ...5.0771

DESCRIPTIVE PHYSICAL OCEANOGRAPHY OF THE EASTERN TROPICAL ATLANTIC ...Atlantic Ocean-general, Environmental Ecology, Fish -non-specific, Productivity - Food Chain, ...4.0127

DEVELOP HIGH-SEAS TUNA FISHERY ...Commercial Fishing, Fishing Gear, Pacific Ocean-general, Tuna, Mackerel, Albacore... , ...5.0084

146 D EASTROPAC ...Marine Biology, Meteorological Studies, Pacific Ocean-east, Tuna, Mackerel, Albacore... , Vertical Distribution, ...4.0113

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EASTERN TROPICAL ATLANTIC COOPERATIVE SURVEY 12 SEPTEMBER TO 20 DECEMBER 1968 ...Atlantic Ocean-general, ...4.0120

SYMBIOSIS OF TROPICAL ZOANTHIDEA AND ZOOXANTHELLAE ...Anthozoa, Messenger RNA , Metabolism, Symbiosis, Zooxanthella, ...5.0642

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Climatography

ARCTIC AIR, SEA AND ICE ...Arctic, Heat and Radiation Transfer, Heat Exchange, Micrometeorology, Sea Ice, Weather Forecasting, ...3.0088

THE POSTPLEISTOCENE OCEANOGRAPHY AND BIOLOGY OF THE EASTERN NORTH PACIFIC ...Marine Biology, Ocean History, Pacific Ocean-east, Pacific Ocean-north, ...7.0158

Physical Climatology

WEATHER PROGRAM - STATION T-3 ...Arctic Ocean, Drift Stations, Energy Exchange Processes, Heat Budget, Patterns, Weather Forecasting, ...3.0060

CLIMATE CHANGE OVER THE POLAR OCEAN ...Arctic Ocean, Heat and Radiation Transfer, Heat Budget, Numerical Analysis-other, ...3.0058

LINE ISLANDS EXPERIMENT ...Boundary Layer Studies, General Synoptic Observations, Line Islands, Satellites, Wind-water Interaction, ...3.0063

ARCTIC UNDERSEAS RESEARCH, JOINT USA-CANADIAN HEAT BUDGET STUDY ...Arctic, Heat and Radiation Transfer, Instrumentation-general, Sea Ice, ...3.0071

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Cloud Formation and Evolution

FLUID DYNAMICS CENTER ...Cloud Physics, Coastlines-shorelines, Model Studies, Satellites, Tropical Cyclones, ...8.0178

Cloud Physics

FLUID DYNAMICS CENTER ...Cloud Formation and Evolution, Coastlines-shorelines, Model Studies, Satellites, Tropical Cyclones, ...8.0178

Cloud Temperature

REMOTE SENSOR OCEANOGRAPHY ...Aerial Photography, Gulf of Mexico, Infrared Radiation, Satellites, Surface Environments, Temperature, ...4.0170

Cumulus

ATMOSPHERIC CONDITIONS ASSOCIATED WITH CUMULUS CONVECTION ...Convection, Meteorologic Model Studies, Shear, Tropical Cyclones, Velocity, ...3.0045

Height - Ceiling

UTILIZATION OF SYNCHRONOUS SATELLITE DATA ...Patterns, Satellites, Technique Development, Velocity, Weather Forecasting, ...4.0173

Patterns

CLOUD PATTERNS RELATED TO SELECTED CIRCULATION SYSTEMS IN EASTERN PACIFIC ...Meteorological Studies, Photographic, Satellites, ...4.0138

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ATMOSPHERIC PROCESSES IN THE TROPICS ...Data Reduction and Analysis, Shear, Statistics-general, Tropic, Tropical Cyclones, ...3.0059

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Radiation Balance

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ANALYSIS AND INTERPRETATION OF SATELLITE RADIATION DATA ...Atmosphere Radiation, Heat Budget, Meteorologic Model Studies, Radiation-general, Satellites, ...4.0009

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Peripheral Nerves

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VISUAL PROJECTION IN SUBMAMMALIAN VERTEBRATES ...Basic Studies, Fish -other, Retina, Visual Organs, ...5.0238

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Coatings-general

DRAG-REDUCING ALGAE ...Algae- General, Fouling, Marine Bacteria, Natural Occurring, Secretions and Products, Wear, Friction, ...5.0681

SUPPORTING SYSTEMS ...Facilities, Underwater-laboratory, ...8.0338

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Paint and Organic

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FRICTIONAL RESISTANCE HULL SCALE AND COATINGS ...Corrosion General, Maintenance-system, Materials Used Undersea, Wear, Friction, ...8.0227

EVALUATION OF BOOTTOP PAINT SYSTEMS FOR OCEAN-GOING SHIPS IN A BOOTTOP PAINT TESTING MACHINE ...Catalysts, Primers, Surface Cleaning, Finishing, Test Methods, Water, ...8.0237

APPLICATION OF ISCC-NBS CENTROID COLORS AND METHOD OF DESIGNATION COLORS ...Colorimetry, Dyes and Coloring, Photography-chemistry, Pigments, Standards, Specifications, ...4.0097

Primers

EVALUATION OF BOOTTOP PAINT SYSTEMS FOR OCEAN-GOING SHIPS IN A BOOTTOP PAINT TESTING MACHINE ...Catalysts, Paint - General, Surface Cleaning, Finishing, Test Methods, Water, ...8.0237

Cobalt

SURVIVAL OF FOOD PATHOGENS IN RADIATION PASTEURIZATION SEAFOOD ...Cell. env.(non-specific & Ot.), Crabs, Food Bacteria, Radiation, Radiation Sensitivity-, ...6.0063

Coelenterata -other

CHEMISTRY AND BIOLOGY OF SOME COELENTERATE NEMATOCYSTS ...Animal Toxins, Cell. organ. & Organoids - ot, Invertebrate Physiology, Predation, ...5.0776

Collections

PORCELLANID CRABS OF AUSTRALIA ...Australia, Crabs, Museum, Nomenclature, Classification, ...5.0354

COPEPOD CRUSTACEANS PARASITIC ON FISHES ...Copepods, Ectoparasites, Fish -non-specific, Indian Ocean-general, Ships and Cruises, Vertical Distribution, ...5.0368

THE ALPHEID SHRIMP OF AUSTRALIA ...Animal Taxonomy, Australia, Pubilications -other, Shrimps - Common, ...5.0425

TREMATODES OF FISHES OCCURRING ON THE WEST COAST OF NORTH AMERICA. ...Comparative Physiology, Nearctic, Pacific Ocean-general, Trematoda -other, ...5.0636

ORGANIZATION OF THE ACADEMYS COLLECTION OF RECENT MARINE, TERRESTRIAL, AND FRESHWATER INVERTEBRATES ...Animal Taxonomy, Invertebrates -non-specific, ...5.0752

REVISION OF THE CLASSIFICATION AND PHYLOGENY OF THE SUBORDER BALANOMORPHA (CIRRIPEDIA - THORACICA) ...Animal Taxonomy, Barnacles, Handbooks, Nomenclature, Classification, Vertical Distribution, ...5.0704

ECOLOGY OF SKELETAL PLANKTON ...Animal Taxonomy, Flagellates, Gastropods -slugs,conch,snails, Paleoenvironments, Temporal Distribution, Vertical Distribution, ...5.0997

THE SYSTEMATICS AND ZOOGEOGRAPHY OF THE BRYOZOAN FAUNA OF THE HAWAIIAN ISLANDS ...Animal Taxonomy, Australian, Bryozoa, Hawaii, Range Or Territorial Distr. , ...5.0542

SHORE FISHES OF ANNOBON AND FERNANDO POO ...Art Work-illustrations-etc, Atlantic Ocean-general, Fish -non-specific, Museum, ...5.0067

STUDY OF FOSSIL SEA TURTLE COLLECTION AT THE INSTITUT ROYAL DES SCIENCES NATURELLES, BRUSSELS, BELGIUM ...Belgium, Description of Fossils, Internal Structure, Reptiles, Tertiary Period, ...7.0177

SYSTEMATICS AND DISTRIBUTION OF WORMFISHES (MICRODESMIDAE) ...Animal Taxonomy, Bone, Fish -other, Vertebrate Anatomy, Vertical Distribution, ...5.0115

STRATIGRAPHIC STUDY OF RADIOLARIA IN DEEP SEA QUATERNARY SEDIMENTS ...Core Analysis, Correlation, Geographical Relations, Order Radiolaria, Quaternary Period, ...7.0178

ANATOMICAL INVESTIGATIONS OF THE LOBODONTINAE ...Ross Sea, Seals, Vertebrate Anatomy, ...5.0614

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PARASITES OF ANTARCTIC VERTEBRATES AND INVERTEBRATES ...Animal Taxonomy, Antarctic Ocean, Ectoparasites, Endoparasites -other, ...5.0658

CONTRACT FOR-PROCESSING OF USARP ROCK SAMPLES ...Antarctica, Classifications, Coring and Dredging, Petrology, Sampling, Ships and Cruises, Thin Sections, ...7.0060

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CRUSTACEAN COLLECTION OF EAST COAST OF UNITED STATES ...Atlantic Ocean-north, Crustacea -non-specific, Estuaries, North Carolina, ...5.0481

FISH COLLECTION OF NORTH CAROLINA AND WESTERN ATLANTIC FISHES ...Atlantic Ocean-north, Fish -non-specific, Fresh Water, North Carolina, ...5.0133

REFERENCE COLLECTION OF GULF MARINE ANIMALS ...Animal Taxonomy, Gulf of Mexico, Invertebrates -non-specific, Vertebrates -non-specific, ...5.0657

MARINE BIOLOGY STUDIES ON FAIRFAX ISLAND ...Australia, Data Acquisition, Islands, Marine Biology, Reefs, ...5.0874

THE TAXONOMY AND ZOOGEOGRAPHY OF THE MAGELONIDAE OF THE WORLD ...Animal Taxonomy, Lugworms, Marine Segmentedworm, Nomenclature, Classification, World Wide, ...5.0570

MARINE POLYCHAETE WORMS OFF THE COLUMBIA RIVER, OREGON ...Animal Taxonomy, Lugworms, Marine Segmentedworm, Marine Biology, ...5.0575

MARINE NEMATODES OF THE CAPE COD AREA ...Animal Taxonomy, Habitat Studies, Nematoda -other, Northeast, ...5.0566

HYPERIID AMPHIPODS FROM THE GULF OF GUINEA ...Animal Taxonomy, Guinea, Oceanography-general, Shrimp - Amphipods, Vertical Distribution, ...5.0387

RELATIONSHIP BETWEEN WATER TEMPERATURE AND SIZE OF PARASITIC COPEPODS ...Copepods, Host Specificity, Size, Temperature, Water Temperature-non-specific, ...5.0390

CANADIAN ARCTIC AND SUBARCTIC POLYCHAETES COLLECTED BY E. H. GRAINGER ...Animal Taxonomy, Lugworms, Marine Segmentedworm, Polar, Sub - Polar, ...5.0576

SYSTEMATICS OF ANTARCTIC SIPUNCULIDS AND ECHIURIDS COLLECTED BY THE ELTANIN EXPEDITION ...Animal Taxonomy, Antarctica, Expeditions, Invertebrates - non-specific, ...5.0578

SYSTEMATIC STUDIES ON MOLLUSKS FROM WALTERS SHOALS, INDIAN OCEAN ...Animal Taxonomy, Ethiopian, Indian Ocean-general, Mollusks -non-specific & Other, ...5.0402

SYSTEMATIC STUDY OF MYODOCOPID OSTRACODS OF THE INDIAN OCEAN ...Animal Taxonomy, Expeditions, Indian Ocean-general, Shrimps - Seed Or Mussel, ...5.0394

NEPHROPID LOBSTERS OF THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean-north, Lobsters, ...5.0396

MARINE BIOLOGICAL INVESTIGATIONS - TAXONOMIC COLLECTION OF THE FRESH AND SALTWATER FISHES OF ALASKA ...Alaska, Animal Taxonomy, Fish -non-specific, Fresh Water, ...5.0008

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BENTHIC PENAEID SHRIMPS (OTHER THAN PENAEUS) FROM THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean-general, Continental Shelf, Shrimps - Common, Vertical Distribution, ...5.0404

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ECOLOGICAL STUDIES OF RADIOACTIVITY IN THE COLUMBIA RIVER ESTUARY AND ADJACENT PACIFIC OCEAN ...Contamination - Water, Organism Sampling Devices, Pacific Ocean-north, Pollutants - Path of , Radioactivity-general, ...6.0172

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PRESERVATION AND DEVELOPMENT OF FOOD PRODUCTS ...Fish -non-specific, Food Raw Quality, Food Transport -other, Packaging, Processed Product Quality, ...6.0084
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LOW NOISE MULTI-CHANNEL HYDROPHONE CABLE ...Amplifiers, Bathymetry, Cables and Transmission Lines, Seismic Studies, Transmission Lines, ...8.0145

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Statistical Information Theory

NATIONAL DATA PROGRAM FOR THE MARINE ENVIRONMENT ...Oceanography-general , ...4.0003

PHOTOGRAPHIC IMAGE EVALUATION ...Cybernetics, Imaging, Photography-chemistry, ...4.0053

Coding

DIGITAL OUTPUT SURVEY DEPTH SOUNDING ...Bathymetry, Digital Computer Applications, Readout Systems, Sonar, Sound Gear, ...8.0123

Signal Detection

DEVELOPMENT OF ANALYSIS TECHNIQUES FOR CLASSIFYING TRANSIENT HYDROACOUSTIC SIGNALS ...Acoustical, Acoustics, Seismic Studies, Transient, ...1.0068

Computer Electronics

Analog-digital Converters

DIGITIZING SYSTEM FOR OCEANOGRAPHIC DATA ...Applied Electronics, Bathymetry, Digital Computers, Instrumental Services, Seismic Studies, Spectral Analysis, ...4.0039

Data Acquisition Systems

TELEMETERING BUOY SYSTEM FOR OCEANOGRAPHIC RESEARCH AND ENIVRONMENTAL PREDICTION ...Buoys, Meteorological Studies, Moorings, Navigation Communication, Oceanography-general, Technique Development, Telemetry-other, ...8.0268

DEVELOPMENT OF AN ELECTRONIC METHOD FOR THE AUTOMATIC SHIPBOARD RECORDING OF DRILL PERFORMANCE DATA ...Data Acquisition, Drilling and Coring, Non-electrical Measurements, Recording Systems, Technique Development, ...8.0247

Data Display

ADVANCE SONAR SYSTEMS ...Instrumental Services, Sonar, Sonar and Echo Sounding, Testing Facilities, Transducers, ...8.0096

Data Transmission Systems

STUDIES OF EARTHQUAKES IN THE CAPE MENDOCINE AREA ...Applied Electronics, Earthquake Location, Earthquakes, Seismic Studies, Telemetry-other, ...7.0088

OCEAN SYSTEM TELEMETRY STUDY ...Applied Electronics, Buoys, Data Acquisition, Moorings, Telemetry-other, ...4.0002

Digital Computers

DIGITIZING SYSTEM FOR OCEANOGRAPHIC DATA ...Analog-digital Converters, Applied Electronics, Bathymetry, Instrumental Services, Seismic Studies, Spectral Analysis, ...4.0039

Readout Systems

DIGITAL OUTPUT SURVEY DEPTH SOUNDING ...Bathymetry, Coding, Digital Computer Applications, Sonar, Sound Gear, ...8.0123

DEVELOPMENT OF FISHNET BATHYKMORGRAPH ...Commercial Fishing, Fishing Gear, Instrumental Services, Nets, ...8.0102

Recording Systems

FOSDIC APPLICATION TO CURRENT-METER RECORDS ...Currents-ocean, Data & Statistics Storage, Research - Development, Technique Development, Water Motion Recorders, ...4.0021

DEVELOPMENT OF AN ELECTRONIC METHOD FOR THE AUTOMATIC SHIPBOARD RECORDING OF DRILL PERFORMANCE DATA ...Data Acquisition, Data Acquisition Systems, Drilling and Coring, Non-electrical Measurements, Technique Development, ...8.0247

COAST GUARDS COASTAL OCEANOGRAPHIC MONITORNG NETWORK ...Automatic Stations, Buoys, Instrumental Services, Telemetry-other, Transducers, ...4.0006

Computer Methods -general

ECOLOGICAL, EXPERIMENTAL AND COMPUTER STUDIES OF ENDOGENOUS RHYTHMICITY ...Biological Rhythms, Brain, Crustacea -non-specific, Locomotion, ...5.0361

EXPERIMENTAL AND BIOMATHEMATICAL ANALYSIS OF THE PHENOMENON OF ATTACK ...Behavioral Ecology, Bluegills, Bream, Environmental Physiology, Largemouth Bass, Minnows, Predation, ...5.0535

A BIBLIOGRAPHY OF THE MARINE MOLLUSKS OF THE INDO-PACIFIC REGION ...Animal Taxonomy, Asia, Bibliography, Mollusks -non-specific & Other, ...5.0398

AUTOMATIC DATA PROCESSING - SEABIRD DISTRIBUTION ...Birds -non-specific, Nomenclature, Classification, Range Or Territorial Distr. , World Wide, ...4.0020

COLLECTION, COMPILATION, AND ANALYSIS OF GULF CATCH STATISTICS AND LOGBOOK DATA ...Alewife,menhaden,shad,herring, Commercial Fishing, Fish Studies -other, ...5.0126

Computers

Analog Computer Applications

ACQUISITION AND INTERPRETATION OF OCEANIC GRAVITY DATA ...Data Reduction and Analysis, Gravity Studies, Ridges, Structural Analysis, Trenches, ...4.0033

MARINE GRAVITY ...Geophysical Equipment, Gravity Studies, Navigation, Satellites, Ships and Cruises, Technique Development, ...7.0128

FISH POPULATION STUDY ...Environmental Ecology, Fish - other, Killifishs - Cyprinodon, Population Dynamics, Tilapia, Cichlids, ...5.0175

Computer Applications

COMPUTER PROCESSING OF MICROSCOPE IMAGERY ...Microscopy, Resolution, ...8.0063

CATAMARAN CONTAINERSHIP FEASIBILITY ...Barges-towboats, Freight, Models, Storage, ...8.0273

AMBIENT SEA NOISE INVESTIGATION ...Acoustic, Acoustical, Noise, Waves, Wind-water Interaction, ...1.0048

SIMULATION MODELS OF SHALLOW-WATER AND COASTAL ENVIRONMENTS ...Gulf of Mexico, Hydrology-general, Model Studies, Sedimentation, Shoreline - Coastline, ...4.0066

STUDY OF THE EXCHANGE OF CARBON DIOXIDE BETWEEN THE ATMOSPHERE AND THE OCEANS ...Carbon, Gases, Meteorological Studies, Particle-gas Transfer, ...1.0081

DESIGN STUDY - AN OPTIMUM FISHING VESSEL FOR THE GEORGES BANK GROUNDFISH FISHERY ...Atlantic Ocean-north, Commercial Fishing, Fishing Gear, Naval Architecture-general, Other-design-and-construction, ...8.0288

AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE - LABORATORY PROCEDURES ...Colorimetry, Conductrometry, Management, Nitrogen, Phosphate, Phosphite, Swamps-marshes, ...5.0761

EFFECTS OF MATERIAL VARIATIONS IN THE COMPUTERIZED DESIGN OF PRIMARY HULL STRUCTURE ...Bulkheads, Engineering Studies-other, Low Alloy Steels, Materials Used Undersea, Strength, Cohesion, ...8.0298

AN OPTIMUM LOADING SEQUENCE FOR CONTAINERSHIPS ...Engineering Studies-other, Freight, Loading/unloading, Model Studies, Packing, ...8.0033

THE INVERSE PROBLEM IN PROPELLER DESIGN ...Marine Propulsion, Rotors-propellers, ...8.0299

MODEL FOR PRELIMINARY EVALUATION OF TOTAL CARGO TRANSPORTATION TIME AND TRANSPORTATION COST FOR ADVANCED CARGO TRANSPORTATION SYSTEMS ...Costs, Freight, Transportation Systems, Yards-docks, ...4.0067

PRELIMINARY CALCULATION OF THE LIFT AND DRAG AND ANGLE OF ATTACK FOR SUBMERGED HYDROFOILS ...Drag, Hydrofoils Crafts, Lift, ...8.0278

MODEL FOR THE PRELIMINARY DESIGN OF SURFACE EFFECT SHIPS ...Drag, Hydrofoils Crafts, Marine Propulsion, Other Models, Ships and Cruises, Waves, ...8.0279

OCEAN DYNAMICS IN THE STRAITS OF GIBRALTAR AND ADJACENT AREAS ...Acoustical, Anti-submarine-warfare, Hydrodynamics, Model Studies, Strait of Gibraltar, Submerged Ships, ...1.0141

OCEANOGRAPHIC INFORMATION PROCESSING TECHNOLOGY ...Data & Statistics Storage, Data Reduction and Analysis, Information Retrieval Methods, Information Storage and File, Oceanography-general, Real Time Systems, ...4.0023

PREDICITION OF SOUND FIELDS BY NORMAL MODE AND OTHER THEORY ...Acoustical, Attenuation, Transmission, ...1.0011

NUMERICAL PREDICTION ...Data Reduction and Analysis, Meteorological Studies, Prediction, Weather Display Systems, Weather Forecasting, ...4.0041

UNSTEADY FLOW AND SALINE INTRUSION IN ESTUARIES ...Channels, Model Studies, Morphology-general, Saline Water Intrusion, Unsteady Flow, ...2.0066

REMOTE SENSING, EVERGLADES AREA, FLORIDA ...Florida, Remote Areas, Swamps-marshes, Visible Light, Water Properties-general, ...4.0161

DISTRIBUTION AND ABUNDANCE OF ZOOPLANKTON IN LAKE ERIE ...Aquatic Ecology, Environmental Ecology, Interbiotic Relat.(non-specif), Lake Erie, Population Dynamics, ...5.0802

SPACE APPLICATIONS TO FISHERIES OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM) ...Commercial Fishing, Forecasting-prediction, Satellites, Water Environment - other, ...4.0172

COMPUTOR SIMULATION OF HYDROID COLONIES ...Growth Rate, Hydra, Portuguese Man-of-war, ...5.0651

Digital Computer Applications

DIGITAL OUTPUT SURVEY DEPTH SOUNDING ...Bathymetry, Coding, Readout Systems, Sonar, Sound Gear, ...8.0123

DECOMPRESSION TABLE DEVELOPMENT ...Decompression Sickness, Divers, Diving and Scuba, Mathematical Biophysic, Medical Studies, Tables, Compilations, Catalogs, ...6.0098

MARINE DIGITAL GRAVITY PROFILING SYSTEM ...Field Characteristics-general, Gravity Studies, Navigation, Special Mission Ships, ...4.0038

GRAVITY AND MAGNETIC DATA COLLECTED DURING THE INTERNATIONAL INDIAN OCEAN EXPEDITION AND IN THE CARIBBEAN SEA ...Data Analysis - General, Data Reduction and Analysis, Gravity Studies, Indian Ocean-general, Magnetic Studies, Research - Development, ...4.0030

FIELD DETECTION AND MEASUREMENT OF INTERNAL WAVES ...Acoustical, Density, Temperature, Tides, Waves-internal, ...2.0125

WOODS HOLE SHIPBOARD DATA PROCESSING ...Data Reduction and Analysis, Gravity Studies, Magnetic Studies, Navigation, Real Time Systems, ...4.0031

AUTOMATED FLOW SYSTEM CALIBRATION ...Aircraft, Controls, Fluids, Transducers, ...8.0071

Hybrid Computer Applications

DELAY LINE COMPUTER ...Acoustical, Heat and Radiation Transfer, Meteorological Studies, Model Studies, Water Motion, ...4.0080

USE OF ON-LINE COMPUTERS FOR ENVIRONMENTAL RESEARCH ...Acoustical, Air-sea Boundary-general, Development of Models, Meteorological Studies, Water Motion, ...4.0081

Conductivity

EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS ...Acoustical, Density, Electrical, Electrolytes, Pressure, Sulfate, Sulfite, Viscosity, ...1.0078

Conjunctive Use

SURFACE AND GROUND WATER POTENTIALITIES OF THE MULLICA RIVER BASIN ...Aqueducts, Economic Impact, Estuaries, Systems Analysis, Water Quality-general, Water Transfer, ...9.0014

Connecticut

MILLSTONE POINT TEMPERATURE SURVEY ...Atomic Plants, Electric Power Plants, Salinity, Temperature, ...1.0181

ORGANIC DEBRIS ON CONNECTICUT BEACHES AND SHORES ...Catabolism and Degradation, Identification, Organic Matter, Physical-general, Shoreline - Coastline, ...6.0143

Connecticut River

POTENTIAL FISHERY FOR RIVER HERRINGS IN CONNECTICUT RIVER ...Alewife,menhaden,shad,herring, Data Acquisition, Life History Studies, Nets, Spawning & Nesting Sites, Survey Studies, ...5.0202

A STUDY OF THE RATE AND PATTERN OF SHAD MIGRATION IN THE CONNECTICUT RIVER UTILIZING SONIC TRACKING APPARATUS ...Alewife,menhaden,shad,herring, Migration, Spawning & Nesting Sites, Tags, Telemetry, ...5.0046

STUDY OF THE RIVER PHASE OF THE LIFE HISTORIES OF ALOSA PSEUDOHARENGUS AND AESTIVALIS ...Alewife,menhaden,shad,herring, Aquatic Ecology, Life History Studies, Spawning & Nesting Sites, ...5.0245

Conservation-general

ISLAND STUDY ...Islands, Land Economics, Recreation Sites, Types of Resources, United States-general, ...9.0005

Consolidation

BOTTOM SOIL PROPERTIES AND FOUNDATIONS ...Bearing Capacity, Foundations-general, Mechanical Properties, Shear Strength, Soil Testing-general, ...8.0332

Construction Sites

PRE-CONSTRUCTION ENVIRONMENTAL SURVEY ...Construction Land Use Effects, Continental Shelf, Environmental Ecology, Organism Sampling Devices, Reefs, ...5.0907

Consultants, Advisory Services

SEARCH AND RESCUE - U.S. COAST GUARD ...Economic Theory, Operational Aspect, Safety, ...6.0130

OCEANOGRAPHY STUDY ACTIVITIES ...Committee-support, Oceanography-general, ...11.0007

WOODS HOLE STUDY ACTIVITIES ...Acoustical, Engineering Studies-general, General Information Services, ...11.0031

CONSULTATIVE AND ADVISORY SERVICES - BATTERY PROBLEMS ...Batteries, Instrumental Services, Standards, Specifications, ...11.0021

FEASIBILITY STUDY ON HORIZONTAL TEST TANK FOR MODEL STUDIES AND COMPONENT TESTING ...Dredging, Equipment, Model Studies, Ocean Mining, Tanks, ...12.0007

SUBJECT INDEX

Continental Shelf

DEVELOPMENT OF A SENSOR, INSTRUMENTATION AND COMMUNICATION SYSTEM FOR A DEEP OCEAN MANNED HABITAT (ATLANTIS) ...Navigation Communication, Ridges, Safety, Submersibles, Underwater-laboratory, ...**8.0107**

DEEP OCEAN TECHNOLOGY ...Diving and Scuba, Survey Studies, Technique Development, ...**8.0049**

THE EVALUATION AND USE OF SUBMERGED RESEARCH VESSELS IN STUDYING CONTINENTAL SHELF ENVIRONMENTS ...Experiments and Tests, Operational Aspect, Submerged Ships, Submersibles, ...**4.0128**

BOTTOM CURRENTS AND THE MOVEMENT OF SEDIMENT ACROSS THE CONTINENTAL SHELF ...Bed Load, Columbia River, Puget Sound, Sediment Transport-general, Unsteady, ...**2.0047**

BIOLOGICAL PRODUCTIVITY IN THE SARGASSO SEA, THE GULF STREAM AND IN THE ATLANTIC COASTAL WATERS OFF CAPE HATTERAS ...Phytoplankton, Primary Productivity, Productivity - Food Chain, Proteins, ...**5.1005**

RADIOISOTOPIC TRACER STUDY TO INVESTIGATE THE MECHANICS OF LITTORAL TRANSPORT AROUND POINT CONCEPTION, CALIFORNIA ...Distribution, Ocean Waves - Currents, Sediment Transport-other, Tracers, Xenon, ...**7.0216**

MARINE GEOLOGY ...California, Distribution, Ocean Waves - Currents, Sedimentation, Submarine Canyons, ...**7.0260**

MARINE GEOLOGY AND GEOPHYSICS ...Crust, Geophysics-general, Ocean Basins, Sedimentation, Textures-structures, ...**7.0048**

THE ECOLOGY OF COCCOLITHOPHORIDACEAE IN THE ATLANTIC COASTAL WATERS OF THE UNITED STATES ...Atlantic Ocean-general, Water Properties-general, ...**5.0841**

SUPPORT OF UNIVERSITY OF GEORGIA MARINE INSTITUTE RESEARCH VESSEL OPERATION ...Continental Slope, Distribution, Environmental Ecology, Estuaries, Geomorphology-topography, Marine Biology, Pollution Sources-general, Ships and Cruises, Textures-structures, ...**12.0026**

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PHYSICAL AND CHEMICAL PROPERTIES OF THE SHELF AND SLOPE WATERS OFF NORTH CAROLINA ...Atlantic Ocean-north, General Sea Water Chemistry, North Carolina, Oceanic Fronts, Water Properties-general, ...**1.0156**

MODERN FORAMINIFERA OFF OREGON ...Foraminifera, Oregon, Pacific Ocean-general, Vertical Distribution, ...**5.0820**

EARLY DIAGENESIS OF CARBONATE SEDIMENTS IN A SUPRATIDAL EVAPORITIC SETTING ...Carbonates-general, Diagenesis, Origin, Persian Gulf, Sedimentary History, Sedimentation, ...**7.0252**

CURATING OF BLAKE PLATEAU CORES ...Collections, Core Analysis, Florida, ...**12.0025**

STRATIGRAPHY OF UNCONSOLIDATED SEDIMENTS ON THE CONTINENTAL SHELVES OF THE CHUKCHI AND NORTHERN BERING SEAS ...Bering Sea, Chuckchi Sea, Core Analysis, Correlation, Oceanic Fronts, Sedimentary History, ...**7.0286**

SYMPOSIUM ON RESEARCH NEEDS AND PRIORITIES FOR MARINE GEOLOGY OF THE GULF OF MEXICO ...Gulf of Mexico, Instrumentation-general, Mechanical Properties, Meetings, Sedimentation, Structural Studies, ...**11.0040**

STUDIES OF BARACLINIC TIDAL MOTIONS ON THE CONTINENTAL SHELF OF THE EASTERN UNITED STATES ...Eastern, Meteorological Studies, Sea Level Variations, Tides, Water Motion, ...**2.0081**

PHYSICAL OCEANOGRPAHY IN OREGON SHELF AND SLOPE WATERS ...Continental Slope, Hydrodynamics, Mixing, Oregon, Thermodynamics, ...**2.0076**

THE ECONOMIC POTENTIAL OF THE MINERAL AND BOTANICAL RESOURCES OF THE U.S. CONTINENTAL SHELF AND SLOPE ...Ag Uses of Nat. resource-other, Continental Slope, Estimates of Reserves, Ocean Mining, Potential of Deposit, ...**7.0013**

MARINE GEOPHYSICS ...Acoustical, Continental Slope, Mechanical Devices, Seismic Studies, Textures-structures, ...**7.0146**

SEISMIC, MAGNETIC, AND ACOUSTIC STUDIES ON THE CONTINENTAL MARGIN OFF WASHINGTON ...Acoustical, Mechanical Properties, Subbottom, Textures-structures, Washington, ...**7.0151**

GRAVITY SURVEY ARCTIC OCEAN ...Bathymetry, Beaufort Sea, Geodetic Surveys, Gravity Studies, Seismic Studies, Structural Studies, ...**7.0154**

INTERNAL WAVE STUDY ...Acoustical, Atlantic Ocean-north, Thermal, Tides, Waves-internal, ...**2.0099**

JOINT STUDY OF THE CONTINENTAL MARGIN OFF OREGON BY OREGON STATE UNIVERSITY AND THE UNITED STATES GEOLOGICAL SURVEY ...Geophysics-general, Mineralogy, Ocean Basins, Oregon, Potential of Deposit, ...**7.0046**

MARINE GEOLOGY OF THE CALIFRONIA CONTINENTAL BORDERLAND WITH EMPHASIS ON FUTURE ECONOMIC DEVELOPMENT AND GENERAL RESOURCE VALUE ...California, Clay Minerals-general, Heavy Elements, Mineralogy, Ocean Mining, ...**7.0010**

KODIAK KING CRAB ENVIRONMENTAL ZONE SURVEY ...Alaska, Environmental Ecology, Horseshoe Or King Crabs, Reproductive System, ...**5.0348**

SPRING DISTRIBUTION OF FISHES ...Commercial Fishing, Data Acquisition, Environmental Ecology, Fish -non-specific, Spring, Temporal Distribution, ...**5.0154**

DISTRIBUTION OF LIFE WITH DEPTH ...Motion Pictures - non-specific, North Carolina, Photography, Vertical Distribution, ...**5.0885**

PACIFIC SALMON FISHERIES - ECONOMICS OF MANAGEMENT ...Appraisals-general, International, Legal Review, Legal Studies-general, Ocean Mining, Science & Technology, ...**10.0006**

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OCEANOGRAPHY ATLAS OF THE NORTH CAROLINA CONTINENTAL MARGIN ...Atlases-maps, Mapping, North Carolina, ...**4.0059**

MARINE MINERAL RESOURCES OF THE NORTH CAROLINA CONTINENTAL MARGIN ...North Carolina, Resource Inventories, ...**7.0026**

OCEANOGRAPHIC SURVEY OF CONTINENTAL SHELF WATERS OFF CHESAPEAKE BAY ...Chesapeake Bay, Marine Biology, Salinity, Temperature, ...**4.0135**

BENTHIC MARINE FAUNA OF THE UPPER SHELF OFF VIRGINIA ...Animal Taxonomy, Benthic Fauna, Benthonic-bottom, Organism Sampling Devices, Virginia, ...**5.0660**

EVOLUTIONARY DEVELOPMENT OF CUSPATE FORELANDS ...Beach, Depositional Features-other, Deposits-other, Development, North Carolina, Shoreline - Coastline, ...**7.0296**

COASTAL AND CONTINENTAL SHELF SEDIMENTATION ...Argentina, Distribution, Sediment Transport-other, Sedimentation, Shoreline - Coastline, ...**7.0212**

MODERN VERSUS RELICT SEDIMENT PATTERNS ON CONTINENTAL MARGINS ...Bermuda, Canada, Distribution, Quaternary Period, Sea Level Changes, ...**7.0214**

BIOLOGICAL OCEANOGRAPHY & DETERIORATION - SHALLOW WATER MARINE SEDIMENTS & WATER COLUMN BACTERIA ...Biology, Instrumentation-general, Marine Bacteria, Nephelometry, Vertical Distribution, ...**5.0807**

SHALLOW WATER OCEANOGRAPHY ...Acoustical, Hydrodynamics, Rhode Island, Surface Environments, Transmission, ...**1.0030**

SHALLOW WATER OCEANOGRAPHY ...Environmental Effects-geologic, Forecasting-prediction, Pressure, Subsurface Environments, Waves, ...**1.0172**

DIVER-ASSISTED OCEANOGRAPHY ...Benthonic-bottom, Currents-bottom, Diving and Scuba, Geomorphology-topography, Mapping, Waves-internal, ...**4.0098**

MARINE HYDROLOGY AND GEOCHEMISTRY, ATLANTIC CONTINENTAL SHELF AND SLOPE ...Atlantic Ocean-north, Chemistry, Continental Slope, Saline Water Intrusion, Sedimentation, ...**7.0070**

RESOURCES OF THE BERING CONTINENTAL MARGIN ...Bering Sea, Dimensions-distribution, Geology-general, Ocean History, Ocean Mining, ...**7.0016**

CENTRAL CALIFORNIA CONTINENTAL MARGIN ...California, Continental Slope, Geologic Maps, San Andreas Fault, Structural Studies, ...**7.0036**

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NIA CONTINENTAL MARGIN ...California, Continents, General Mineralogic Properties, Geochronology-general, Mineralogy, ...7.0223

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WORLD WIDE MARINE MINERAL RESOURCES ...Continental Slope, Economics, Mapping, Potential of Deposit, Resource Inventories, ...4.0056

GEOLOGICAL, GEOPHYSICAL, OCEANOGRAPHIC, AND ECOLOGICAL DATA ON WORLDWIDE BASIS, ON AREAS OF HEAVY METALS POTENTIAL ...California, Drilling and Coring, Oregon, Placer, Potential of Deposit, ...7.0005

INFLUENCE OF THE PHYSICAL ENVIRONMENT ON DISTRIBUTION OF YOUNG STAGES OF COASTAL GAME FISH ...Environmental Ecology, Fish -non-specific, Maturity & Growth Stages, Physical-general, Range Or Territorial Distr. , ...5.0211

PRE-CONSTRUCTION ENVIRONMENTAL SURVEY ...Construction Land Use Effects, Construction Sites, Environmental Ecology, Organism Sampling Devices, Reefs, ...5.0907

BENTHIC PENAEID SHRIMPS (OTHER THAN PENAEUS) FROM THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean-general, Collections, Shrimps - Common, Vertical Distribution, ...5.0404

BOTTOM TOPOGRAPHY AND SEDIMENTS--MIDDLE ATLANTIC SHELF ...Distribution, Geomorphology-topography, ...4.0055

CIRCULATION ON THE CONTINENTAL SHELF ...Atlantic Ocean-north, Circulation-general, Eastern, Water Motion Recorders, ...2.0027

Continental Slope

SUPPORT OF UNIVERSITY OF GEORGIA MARINE INSTITUTE RESEARCH VESSEL OPERATION ...Continental Shelf, Distribution, Environmental Ecology, Estuaries, Geomorphology-topography, Marine Biology, Pollution Sources-general, Ships and Cruises, Textures-structures, ...12.0026

PHYSICAL OCEANOGRPAHY IN OREGON SHELF AND SLOPE WATERS ...Continental Shelf, Hydrodynamics, Mixing, Oregon, Thermodynamics, ...2.0076

THE ECONOMIC POTENTIAL OF THE MINERAL AND BOTANICAL RESOURCES OF THE U.S. CONTINENTAL SHELF AND SLOPE ...Ag Uses of Nat. resource-other, Continental Shelf, Estimates of Reserves, Ocean Mining, Potential of Deposit, ...7.0011

MARINE GEOPHYSICS ...Acoustical, Continental Shelf, Mechanical Devices, Seismic Studies, Textures-structures, ...7.0146

OCEAN-SEDIMENTS AND CRUSTAL STRUCTURES IN THE BHAMIAN-CARIBBEAN AREA ...Caribbean Sea, Crust, Ocean Basins, Soil Properties - Other, Textures-structures, ...7.0109

MARINE HYDROLOGY AND GEOCHEMISTRY, ATLANTIC CONTINENTAL SHELF AND SLOPE ...Atlantic Ocean-north, Chemistry, Continental Shelf, Saline Water Intrusion, Sedimentation, ...7.0070

CENTRAL CALIFORNIA CONTINENTAL MARGIN ...California, Continental Shelf, Geologic Maps, San Andreas Fault, Structural Studies, ...7.0036

WORLD WIDE MARINE MINERAL RESOURCES ...Continental Shelf, Economics, Mapping, Potential of Deposit, Resource Inventories, ...4.0056

Control of . . .

Aquatic Plants

Aquatic Vegetation -ns

ENERGETICS OF PALAEMONETES PUGIO AND THE WEEDBED COMMUNITY OF SOUTH CREEK ESTUARY ...Energy Budgets, Estuaries, Habitat Studies, North Carolina, Shrimps - Common, ...5.0482

Control Systems

FLUIDIC CONTROL SYSTEM COMPENSATOR ...Control-systems, Controls, ...8.0193

FISH GUIDING ...Animal Distr. (non-specific), Fish -non-specific, Instrumental Services, Management -other, Water Environment -other, ...8.0015

TECHNIQUES OF PLANNING ...Application, Management, Mathematical Analysis, Operations Research, Planning, Southern, Systems Analysis, ...9.0017

Filtering Theory

TROPICAL ANALYSIS AND FORECASTING ...Mathematical Analysis, Meteorologic Model Studies, Pressure-density, Tropic, Weather Forecasting, ...3.0061

Convection

FISHERIES OCEANOGRAPHY AND ENVIRONMENTAL ASSESSMENT AND PREDICTION ...Commercial Fishing, Oceanography-general, Spacecraft Sensory Devices, Thermal, ...4.0150

STUDY OF THE DISTRIBUTION OF RADIONUCLIDES IN THE OCEAN DETAILED EXPLORATION OF CS137 IN THE OCEAN ...Cesium, Chemical Analysis (water), Circulation-general, Pacific Ocean-north, Radioactivity, ...1.0080

AIR/SEA INTERACTION STUDY ...Mixing, Profiles, Thermal, Thermocline, Waves, ...2.0114

CONVECTIVE STUDIES ...Pacific Ocean-north, Sonar, Thermal, ...2.0011

PHYSICAL OCEANOGRAPHY ...Hawaii, Heat and Radiation Transfer, Mixing, Thermal, Wind-water Interaction, ...3.0034

VERTICAL MOTIONS ...Gulf Stream, Hydrodynamics, Water Motion Recorders, ...2.0060

THE CONTRIBUTION OF ADVECTION AND LOCAL HEATING TO THE MAINTENANCE OF THE THERMAL STRUCTURE IN THE NORTH PACIFIC OCEAN ...Circulation-general, Heat and Radiation Transfer, Mixing, Pacific Ocean-north, Thermal, ...1.0183

NATURE AND VELOCITY OF CURRENTS AND OTHER FLOWS IN SUBMARINE CANYONS ...Fans, Ocean Waves - Currents, Sedimentation, Submarine Canyons, Turbidity Currents, Water Motion Recorders, ...2.0008

PHYSICAL AND CHEMICAL ATLAS ...Atlases-maps, General Sea Water Chemistry, Indian Ocean-general, Water Analysis-general, Water Properties-general, ...4.0026

RESEARCH IN OCEANIC PHYSICS ...Atlantic Ocean-south, Mixing, Oceanic Fronts, Thermodynamics, Wind-water Interaction, ...2.0059

MEDITERRANEAN OCEANOGRAPHY ...Data Analysis - General, Heat and Radiation Transfer, Mediterranean Sea-general, Ships and Cruises, Surface Environments, ...4.0132

VERTICAL OCEAN CIRCULATION ...Circulation-general, Model Studies, Oceanic Fronts, Subsurface Environments, ...2.0036

FUNDAMENTAL PROBLEMS IN HYDRODYNAMICS ...Hydrodynamics, Ordnance, Survey Studies, Waves, Waves-internal, ...2.0102

CHEMICAL OCEANOGRAPHY ...Aquatic Ecology, Circulation-general, Technique Development, Trace Elements, ...1.0134

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SUPPORT OF THE R/V EASTWARD ...Caribbean Sea, Continental Shelf, Facilities, Marine Biology (non-specific), Ships and Cruises, Training Grants, Fellowships, ...12.0039

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ACCUMULATION OF RADIOACTIVITY BY INVERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Contamination - Water, Diagnostic Procedures, Radioactivity-general, Reactor Sites & Rad Waste, ...5.0474

ACCUMULATION OF RADIOACTIVITY BY ORGANISMS IN EXPERIMENTAL MARINE ENVIRONMENTS ...Contamination - Water, Estuaries, Laboratory, Radioactivity, ...5.0911

THE EFFECTS OF RADIATION ON THE PHYSIOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Radioactive Fallout, ...5.0294

THE EFFECTS OF RADIATION ON THE MORPHOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Fish -other, Radiation Sensitivity-, Vertebrate Anatomy, Vertebrates Excl. man, ...5.0295

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SEDIMENT STRUCTURE ...Distribution, Geosynclines, Sediment Transport-general, Shelf Areas, Textures-structures, ...7.0204

GEOPHYSICAL INVESTIGATIONS IN THE CORAL SEA ...Buoys, Crust, Regional Structure, Seismic Refraction, Structural Studies, ...7.0130

Core Analysis

GRANT FOR STUDY OF SEA FLOOR CORES AND PHOTOS ...Coring and Dredging, Photography, ...7.0258

RADIATION, DOSIMETRY, CORRELATION AND DATING OF CALCAREOUS DEEP-SEA CORES ...Carbonates-general, Correlation, Radioactive Dating, Sedimentation, Thermoluminescence, ...7.0251

MARINE SEDIMENTS ...Biology, Chemistry, Physical Properties, Subbottom, Textures-structures, ...7.0264

RADIOLARIA IN SEDIMENTS ...Biogenous, Order Radiolaria, Pacific Ocean-general, Population - Distribution, Tertiary Period, ...7.0160

X-RADIOGRAPHIC AND ELECTRONIC FLUOROSCOPIC EQUIPMENT ...Equipment Purchase Operation, Instrumental Services, Radiograph, Radiometer, X Ray Tubes, ...8.0094

MULTIVARIATE ANALYSIS OF MICROPALEONTOLOGICAL DATA FROM DEEP-SEA CORES ...Data Reduction and Analysis, Development of Models, Multivariate Analysis, Order Foraminifera, Paleotemperature, Population - Distribution, ...5.0827

CARBON ISOTOPE GEOTHERMOMETRY ...Carbon, Carbonaceous Substance, Chemistry, Geologic Thermometry, Paleotemperature, Plankton (non-specific), Temperature, ...7.0079

LITHOLOGICAL AND MICROPALEONTOLOGICAL INVESTIGATION OF OCEAN SEDIMENT CORES ...Correlation, Paleoclimatology, Quaternary Period, Sedimentary History, Tertiary Period, ...7.0257

STRATIGRAPHIC AND TAXONOMIC-PHYLOGENETIC STUDIES ON PLANKTONIC FORAMINIFERA ...Cretaceous Period, Intercontinental Stratigraphy, Order Foraminifera, Structure-general, Tertiary Period, ...7.0182

STRATIGRAPHIC STUDY OF RADIOLARIA IN DEEP SEA QUATERNARY SEDIMENTS ...Collections, Correlation, Geographical Relations, Order Radiolaria, Quaternary Period, ...7.0178

CURATING OF BLAKE PLATEAU CORES ...Collections, Continental Shelf, Florida, ...12.0025

MARINE GEOLOGY OF THE SUB-ANTARCTIC PACIFIC REGION ...Antarctic Ocean, Diagenesis, Distribution, Origin, Petrology, Sedimentary History, ...7.0049

BIOFACIES STUDY OF BENTHONIC FORAMINIFERA IN OCEAN SEDIMENT CORES ...Biofacies, External Structure, Order Foraminifera, Paleontology, Population - Distribution, ...7.0175

STRATIGRAPHY OF UNCONSOLIDATED SEDIMENTS ON THE CONTINENTAL SHELVES OF THE CHUKCHI AND NORTHERN BERING SEAS ...Bering Sea, Chuckchi Sea, Continental Shelf, Correlation, Oceanic Fronts, Sedimentary History, ...7.0286

A PALEOMAGNETIC STUDY OF TERTIARY AND PLEISTOCENE OCEANIC CORES ...Antarctic Ocean, Field Reversals, Pacific Ocean-north, Paleomagnetism, Quaternary Period, Tertiary Period, ...7.0166

PALEOTEMPERATURE RESEARCH ...Marine Organisms, Order Foraminifera, Paleotemperature, Quaternary Period, ...7.0161

GEOCHEMISTRY OF MID-ATLANTIC RIDGE SEDIMENTS ...Atlantic Ocean-general, Chemistry, Correlation, Geochronology-general, Ridges, ...7.0071

AN INVESTIGATION OF THE MASS PHYSICAL PROPERTIES OF CARBONATE MUD SEDIMENTS ...Carbon-14, Carbonates-other, Density, Physical Properties, Porosity, ...7.0225

DEPOSITIONAL PROCESSES MARGINAL TO LARGE ANTARCTIC ICE SHELVES ...Antarctic Ocean, Deposits, Environment, Sedimentary History, Sedimentation, ...7.0198

MAGNETIC PROPERTIES OF ANTARCTIC MARINE SEDIMENTS AND ROCKS ...Antarctica, Extinction, Field Reversals, Rock & Mineral Magnetics, ...7.0233

PLEISTOCENE OCEANOGRAPHY AS RECORDED IN DEEP SEA SEDIMENT CORES ...Correlation, Geographical Relations, Paleoclimatology, Paleotemperature, Quaternary Period, ...7.0165

LAKE SUPERIOR CORING III ...Lake Superior, Sedimentology-general, Seismic Studies, Subsurface, Textures-structures, ...7.0247

STRATIGRAPHY AND PALEOECOLOGY OF FOSSIL SILICOFLAGELLATES FROM ANTARCTIC DEEP-SEA CORES ...Antarctic Ocean, Correlation, Field Reversals, Fossil Zones, Paleontology, Paleotemperature, Phylum Protozoa, ...7.0169

DEEP SEA SEDIMENTS IN THE NORTH PACIFIC FROM STUDIES OF THEIR RADIOLARIAN CONTENT ...Biogenous, Distribution, Pacific Ocean-north, Protozoa - other, Sedimentation, ...7.0285

PROPERTIES AND ORIGIN OF SEDIMENTS IN THE NORTHEAST PACIFIC OCEAN ...Carbon-14, Origin, Pacific Ocean-east, Physical Properties, Washington, ...7.0287

RESEARCH IN CORE ANALYSIS ...Acoustical, Coring and Dredging, Geomorphology-topography, Model Studies, Physical Properties, ...7.0263

SEA-FLOOR SEDIMENTS AND ROCK STUDIES ...Atlantic Ocean-north, Biogenous, Microfossils, Paleomagnetism, Petrology, Ridges, Sedimentation, ...7.0040

BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SALT MARSH ENVIRONMENT -...Aquatic Soils, Identification, Marine Bacteria, Salinity, Swamps-marshes, Temperature, Water Level Fluctuation, ...5.0763

ALPINE LIMNOLOGY PROJECT ...Dust - Particulate Matter, Extrusives, Hawaii, Lakes, Mountains-alpine, Volcanoes, ...7.0236

DIAGENESIS OF CARBONATE SEDIMENTS ...Carbonates-general, Diagenesis, Geochemistry-general, Pore Fluids, Trace Element Analysis, ...7.0266

ABYSSAL OSTRACODES OF THE WORLD ...Abyssal, Shrimps - Seed Or Mussel, Vertical Distribution, World Wide, ...5.0386

GEOLOGICAL OCEANOGRAPHY - ACOUSTICAL PROPERTIES OF SEDIMENTS ...Acoustical, Geomorphology-topography, Mechanical Properties, Physical Properties, Scattering, ...7.0101

Coring and Dredging

GRANT FOR STUDY OF SEA FLOOR CORES AND PHOTOS ...Core Analysis, Photography, ...7.0258

ANALYSIS OF PHYSICAL AND CHEMICAL PROPERTIES OF DEEP SEA CORES ...Chemistry, Physical Properties, ...7.0259

RELATIONSHIPS BETWEEN RATES OF SEDIMENT ACCUMULATION & CHANGES WITH DEPTH OF CERTAIN MASS PHYSICAL PROPERTIES IN MARINE SEDIMENTS ...California, Interstitial - Connate Water, Pacific Ocean-east, Rate of Deposition, Shear Strength, ...8.0335

INVESTIGATE METHODOLOGY FOR MEASURING OCEANIC PROPERTIES LEADING TO THE TOTAL ENVIRONMENTAL SURVEY OF A SELECTED OCEAN AREA ...Oceanic - Pelagic, Physical Properties, Radioactivity, Submersibles, Technique Development, ...8.0061

ARCTIC BASIN HEAT FLOW ...Arctic, Crust, Geothermal Gradient, Heat Flows, Physical Properties, ...7.0105

RECENT AND ANCIENT FAUNAS OF A DROWNED ISLAND CHAIN (MID-PACIFIC MOUNTAINS) ...Benthic Fauna, Biofacies, Hawaii, Seamounts-guyots, ...5.0863

MOHOLE SITE STUDIES ...Earth Interior, Hawaii, Pacific Ocean-north, Seismic Studies, Structure Location, ...7.0097

ABYSSAL PLAIN SEDIMENTATION AND STRATIGRAPHY OFF OREGON ...Abyssal, Bathymetry, Paleoclimatology, Sedimentation, Turbidity Currents, ...7.0272

THE MARINE GEOLOGY OF THE SOUTHERN OCEAN ...Antarctic Ocean, Chemistry, Distribution, Mineralogy, Petrology, ...7.0067

CARBON-14 AGE PROFILE OF A HAWAIIAN REEF ...Anthozoa, Carbon-14, Growth Rate, Hawaii, Reefs, Sea Level Variations, ...7.0051

ROCK SAMPLING AND GEOPHYSICAL STUDIES IN THE TONGA KERMADEC TRENCH SOUTHWEST PACIFIC ...American Samoa, Equipment Purchase Operation, Pacific Ocean-west, Photography, Seismic Reflection, Trenches, ...7.0093

ATLANTIC OCEAN CRUSTAL STUDIES ...Atlantic Ocean-general, Bathymetry, Crust, Heat Flow Measurements, Seismic Reflection, ...7.0116

STABLE ISOTOPE STUDIES ON COEXISTING MINERALS IN MARINE SEDIMENTS ...Diagenesis, Genetic Relationships, Mineralogy, Red Sea, Salinity, Thermal, ...1.0106

DEEP-SEA CORE MAGNETOMETER AND A CORE ORIENTATION SYSTEM ...Direction, Magnetometers, Rock & Mineral Magnetics, ...**8.0140**

METEOROLOGICAL SUPPORT OF DEEP-SEA DRILLING OPERATIONS ...Drilling and Coring, Meteorological Studies, Teaching and Research, Waves, Weather Forecasting, ...**12.0013**

CORING OF THE VARVED SEDIMENTS IN SAANICH INLET ...Canada, Geochronology-general, Local Stratigraphy, Pacific Ocean-east, Varves, ...**7.0282**

GEOPHYSICAL AND GEOLOGICAL STUDY OF THE DARWIN RISE ...Bathymetry, Geophysics-general, Gravity Studies, Magnetic Studies, Ocean Basins, Pacific Ocean-west, Photography, Refraction, Ridges, Seamounts-guyots, ...**7.0112**

CONTRACT FOR-PROCESSING OF USARP ROCK SAMPLES ...Antarctica, Classifications, Collections, Petrology, Sampling, Ships and Cruises, Thin Sections, ...**7.0060**

GEOPHYSICAL AND GEOCHEMICAL STUDY OF RED SEA MINERAL DEPOSITS ...Gulf of Aden, Igneous Activity - Volcanism, Mineralogy, Red Sea, Thermal, ...**7.0023**

DEEP SEA PHOTOGRAPHIC SYSTEM AND A BOX CORER ...Abyssal, Benthonic-bottom, Photography, ...**8.0141**

EFFECTS OF DEEP SEA SEDIMENTS ON SUDDEN IMPACT, AS FROM DISASTER VEHICLES ...Engineering Studies-other, Marine Soils, Mechanical Properties, Physical Properties, Shear Strength, ...**7.0228**

RESEARCH IN CORE ANALYSIS ...Acoustical, Core Analysis, Geomorphology-topography, Model Studies, Physical Properties, ...**7.0263**

ESTUARINE DREDGE HOLE INVESTIGATIONS ...Aquatic Ecology, Estuaries, Fish -non-specific, Habitat Studies, ...**5.0908**

SURVEY OF A POTENTIAL HARD CLAM FISHERY ...Clams, Commercial Fishing, Estuaries, Georgia, Spawning & Nesting Sites, ...**5.0420**

SEDIMENTOLOGY AND GEOLOGIC HISTORY OF HUMBOLDT BAY, CALIFORNIA ...Bays, California, Geologic History-general, Pacific Ocean-east, Physical Properties, ...**7.0193**

DEVELOPMENT OF OFFSHORE SOURCES OF SAND SUITABLE FOR BEACH RESTORATION AND NOURISHMENT ...Beach, Mapping, Ocean Mining, Shoreline Structures, Size, ...**7.0012**

DEVELOPMENT OF WIRE-LINE CORING TECHNIQUE FOR *SAMPLING* UNCONSOLIDATED DEPOSITS ...Alaska, Bottom Sampling Device, Mechanical Properties, Mineralogy, Technique Development, ...**8.0249**

SAMPLING CAMPAIGN ON CORONADO BANK, OFF SOUTHERN CALIFORNIA ...Banks, California, Chemistry, Distribution, Phosphate, Phosphite, ...**7.0003**

DEVELOPMENT, TESTING AND EVALUATION OF MODIFICATIONS REQUIRED TO ADAPT DRILLING SAMPLING SYSTEMS TO THE PLATFORM ...Bottom Sampling Device, Drilling and Coring, Equipment, Platforms, Technique Development, ...**8.0256**

LABORATORY MODEL STUDIES OF PENETRATION INTO A SIMULATED COHESIONLESS DETRITUS ...Gravel, Mechanical Properties, Model Studies, Soil Sampling, Technique Development, ...**8.0245**

LABORATORY MODEL STUDIES ON DISTURBANCE OF DETRITUS BY PENETRATION ...Disturbed/undisturbed, Model Studies, ...**8.0252**

LABORATORY STUDIES TO CORRELATE ENGINEERING PROPERTIES OF MARINE PLACER MATERIALS WITH SAMPLING TOOL PERFORMANCE ...Gold, Laboratory Analysis, Mechanical Properties, Placer, Scientific-service-support, ...**8.0244**

Corrosion, Deterioration

Agents

Atmospheric, Gases

COMBUSTION OF RESIDUAL FUEL WITH MASSIVE RECIRCULATION ...Alloys, Combustion Products, Fuels, ...**8.0226**

Biological

MICROBIAL CORROSION AND DETERIORATION OF NAVAL MATERIALS ...Classification Or Taxonomy, Fouling, Ionic Effect, Marine Bacteria, Materials Used Undersea, ...**8.0203**

PILING PRESERVATIVES THRESHOLD STUDIES ...Fouling, Massachusetts, North Carolina, Preservatives, Wood, ...**8.0232**

THE ROLE OF MARINE ORGANISMS IN THE DEGRADATION OF NAVAL MATERIALS ...Marine Bacteria, Materials Used Undersea, Model Studies, Reaction Rates, ...**8.0241**

MARINE-BACTERIA CULTURE ...Bacterial Culture, Fouling, Isolation From Nat. environ. , Marine Bacteria, Water Bacteria, ...**5.0849**

THE ROLE OF SULFUR BACTERIA IN CORROSION AND DETERIORATION ...Autotrophic, Fouling, Marine Bacteria, Plasma Membrane, Sulfur Bacteria, ...**5.0805**

MICROBIAL CORROSION IN THE MARINE ENVIRONMENT ...Biodegradation, Carbon, Fouling, Marine Fungi (non-specific), Water, ...**5.0769**

MECHANISMS OF ATTACHMENT OF MARINE BACTERIA TO SURFACES ...Adsorption & Interface, Corrosion Prevention-other, Fouling, Marine Bacteria, ...**5.0810**

DEEP-WATER FOULING ...Fish -non-specific, Fouling, Predation, Vertical Distribution, ...**8.0233**

MICROBIAL CORROSION ...Alloys, Fouling, Marine Bacteria, Sulfur Bacteria, Water, ...**8.0207**

CHEMICAL WOOD PRESERVATIVE TREATMENTS ...Corrosion Prevention-other, Creosote, Fouling, Wood Preservatives-non-specif, ...**8.0197**

PRESERVATION OF WOODS IN THE MARINE ENVIRONMENT ...Fouling, Habitat Studies, Marine Fungi (non-specific), Materials Used Undersea, Preservatives, Wood, ...**8.0216**

BIOLOGICAL OCEANOGRAPHY AND DETERIORATION, DEEP OCEAN-HIGH PRESSURE BACTERIA ...Biology, Chemistry, Identification, Microorganisms (non-specific), Submersibles, ...**8.0236**

Soils

STEEL PILING ...Corrosion Prevention-other, Fouling, Low Alloy Steels, Polarization, Water, ...**8.0208**

METALS FOR DEFENSE ...Alloys, Corrosion Prevention-other, Water, ...**8.0209**

Water

CORROSION RESEARCH ...Cathodic Protection, Corrosion General, Fouling, Galvanic, ...**8.0199**

ANTIFOULING RESEARCH ...Corrosion Prevention-other, Fouling. Materials Used Undersea, ...**8.0200**

EVALUATION OF BOOTTOP PAINT SYSTEMS FOR OCEAN-GOING SHIPS IN A BOOTTOP PAINT TESTING MACHINE ...Catalysts, Paint - General, Primers, Surface Cleaning, Finishing, Test Methods, ...**8.0237**

OCEAN ENGINEERING RESEARCH ...Alloys, Engineering Studies-general, Materials Used Undersea, Moorings, Water Properties-general, ...**8.0050**

MICROBIAL CORROSION IN THE MARINE ENVIRONMENT ...Biodegradation, Biological, Carbon, Fouling, Marine Fungi (non-specific), ...**5.0769**

STEEL PILING ...Corrosion Prevention-other, Fouling, Low Alloy Steels, Polarization, Soils, ...**8.0208**

METALS FOR DEFENSE ...Alloys, Corrosion Prevention-other, Soils, ...**8.0209**

MICROBIAL CORROSION ...Alloys, Biological, Fouling, Marine Bacteria, Sulfur Bacteria, ...**8.0207**

DESIGN AND CONSTRUCTION ...Coatings-general, Environmental Effects-geologic, Hydrodynamic Structures, Safety, Underwater-construction, ...**8.0333**

CORROSION MITIGATION ...Corrosion Prevention-other, Deep, Fouling, Low Alloy Steels, Pre-stressed, ...**8.0205**

Corrosion General

CORROSION RESEARCH ...Cathodic Protection, Fouling, Galvanic, Water, ...**8.0199**

FRICTIONAL RESISTANCE HULL SCALE AND COATINGS ...Maintenance-system, Materials Used Undersea, Paint - General, Wear, Friction, ...**8.0227**

BIOLOGICAL OCEANOGRAPHY AND DETERIORATION, POLYMER STUDIES ...Lubricants and Fluids, Marine Biology, Marine Biology (non-specific), Plankton (non-specific), Wear, Friction, ...**8.0235**

Durability, Deterioration

CHEMICAL EXPLOSIONS, PACKAGING AND HANDLING AT SEA ...Ammonia, Explosions, Detonation, Packaging, Safety, ...**8.0130**

ENERGY CONVERSION MATERIALS AND COMPONENTS ...Electrode, Fuel Cell-other, Hydrazine, Hydrocarbon, Pressure, ...**8.0223**

Effects and Mechanisms

Cavitation

PHYSICAL ACOUSTICS AND THE PROPERTIES OF MATTER ...Acoustical, Constants, Ultrasonic Frequency, Velocimeter, Velocity, Water, ...1.0031

Galvanic

CORROSION RESEARCH ...Cathodic Protection, Corrosion General, Fouling, Water, ...8.0199

Stress Corrosion

STRUCTURAL TITANIUM ALLOYS -120/150 KSI YIELD STRENGTH ...Fatigue, Materials Used Undersea, Strength - Weight Ratio, Stress Concentration-toughness, Titanium, ...8.0220

HY 130-150 STRUCTURAL STEELS ...High Yield, Low Alloy Steels - Other, Materials Used Undersea, Stress Concentration-toughness, Welding - Other, ...8.0221

Prevention

Cathodic Protection

CORROSION RESEARCH ...Corrosion General, Fouling, Galvanic, Water, ...8.0199

MICROBES AND CORROSION ...Extracellular-enzymes, Fouling, Iron, Metals -non-specific, Microorganisms (non-specific), Respiration, ...8.0228

Corrosion Prevention-other

ANTI-FOULING MEANS FOR MARINE PROPELLERS ...Fouling, Marine Propulsion, Materials Used Undersea, ...8.0240

NEW APPROACHES TO BIOFOULING ASSAY ...Bioassays, Fouling, Marine Biology (non-specific), Paint - General, Powder, ...5.0757

ANTIFOULING RESEARCH ...Fouling, Materials Used Undersea, Water, ...8.0200

MECHANISMS OF ATTACHMENT OF MARINE BACTERIA TO SURFACES ...Adsorption & Interface, Biological, Fouling, Marine Bacteria, ...5.0810

STEEL PILING ...Fouling, Low Alloy Steels, Polarization, Soils, Water, ...8.0208

METALS FOR DEFENSE ...Alloys, Soils, Water, ...8.0209

CHEMICAL WOOD PRESERVATIVE TREATMENTS ...Biological, Creosote, Fouling, Wood Preservatives-non-specif, ...8.0197

CORROSION MITIGATION ...Deep, Fouling, Low Alloy Steels, Pre-stressed, Water, ...8.0205

Inhibitors

FOULING OF SENSORS ...Fouling, Instrumentation-general, Marine Biology, Organometallics, ...8.0239

Costa Rica

CONTINUITY OF CLIPPERTON AND CLARION FRACTURE ZONES ...Faults, Geomorphology-topography, Gravity Studies, Seismic Reflection, Structural Studies, ...7.0090

Creosote

CHEMICAL WOOD PRESERVATIVE TREATMENTS ...Biological, Corrosion Prevention-other, Fouling, Wood Preservatives-non-specif, ...8.0197

Crustacea

Barnacles

REVISION OF THE CLASSIFICATION AND PHYLOGENY OF THE SUBORDER BALANOMORPHA (CIRRIPEDIA - THORACICA) ...Animal Taxonomy, Collections, Handbooks, Nomenclature, Classification, Vertical Distribution, ...5.0704

RESEARCH ON THE BIO-SYSTEMATICS OF THE CIRRIPEDIA ...Biological Rhythms, Developmental Physiology, Visual Organs, ...5.0364

BARNACLES OF THE EASTERN PACIFIC ...Life History Studies, Pacific Ocean-east, ...5.0515

SYSTEMATICS OF MARINE SYMBIOTIC CRUSTACEA FROM INVERTEBRATES ...Animal Taxonomy, Copepods, Life History Studies, Symbiosis, ...5.0516

STUDIES ON MOLTING, GROWTH, AND DEVELOPMENT IN ACORN BARNACLES AND LARVAL DECAPODS ...Biological Rhythms, Developmental Physiology, Endocrine System, Fouling, ...5.0296

MECHANISMS OF CALCIUM CARBONATE DEPOSITION ...Biogeochemical Process, Calcium, Chemical Reactions, Derivatives, Fouling, ...5.1015

STUDIES IN MICRONEUROPHYSIOLOGY ...Brain, Contraction and Relaxation, Gastropods -slugs,conch,snails, Musculoskeletal System, ...5.0362

Copepods

PARASITIC COPEPODA %CRUSTACEA*ROM INVERTEBRATES AND FISHES ...Animal Taxonomy, Ectoparasites, Indian Ocean-general, Invertebrate Anatomy, ...5.0451*

COPEPOD CRUSTACEANS PARASITIC ON FISHES ...Collections, Ectoparasites, Fish -non-specific, Indian Ocean-general, Ships and Cruises, Vertical Distribution, ...5.0368

A STUDY OF THE ECOLOGY OF THE MICROFAUNA LIVING BETWEEN INTERTIDAL MARINE SEDIMENTS ...Beach, Crustacea -non-specific, Intertidal Areas, New England Province, Salinity, ...5.0793

SYSTEMATICS OF MARINE SYMBIOTIC CRUSTACEA FROM INVERTEBRATES ...Animal Taxonomy, Barnacles, Life History Studies, Symbiosis, ...5.0516

SYSTEMATIC STUDIES OF ANTARCTIC COPEPODS ...Animal Taxonomy, Antarctic Ocean, Mixing, ...5.0461

PLANKTON ECOLOGY ...Aquatic Ecology, Lake Michigan, Plankton Sampling, Ships and Cruises, Zooplankton, ...5.0803

SYSTEMATICS, BIOLOGY, AND HYDROGRAPHIC RELATIONS OF SOME SPECIES OF CALANUS (CRUSTACEA, COPEPODA) ...Animal Taxonomy, Invertebrate Anatomy, Oceanic Fronts, Vertical Distribution, ...5.0367

ANNUAL PHYTOPLANKTON PRODUCTION IN PUGET SOUND WATERS ...Invertebrate Culture, Phytoplankton, Puget Sound, Standing Crops, Tides, ...5.0931

ENERGY AND ELEMENT TRANSFER IN LOWER MARINE TROPHIC LEVELS ...Energy Budgets, Oregon, Phytoplankton, ...5.0823

BIOCHEMICAL AND BIOPHYSICAL STUDIES OF THE MARINE ENVIRONMENT ...Energy, Energy Budgets, Organics, Productivity - Food Chain, ...5.0767

COPEPODS PARASITIC ON NEEDLEFISHES ...Aquatic Ecology, Ectoparasites, Fish -other, Nomenclature, Classification, Organic Evolution, ...5.0389

RELATIONSHIP BETWEEN WATER TEMPERATURE AND SIZE OF PARASITIC COPEPODS ...Collections, Host Specificity, Size, Temperature, Water Temperature-non-specific, ...5.0390

COPEPODS PARASITIC ON SHARKS OF THE WEST COAST OF FLORIDA ...Animal Taxonomy, Ectoparasites, Florida, Sharks, ...5.0391

SYSTEMATICS OF CALIGOID COPEPODS ...Animal Taxonomy, Ectoparasites, Host Specificity, Nomenclature, Classification, ...5.0392

SYNECOLOGY OF CARIBBEAN SPONGES ...Algae- General, Caribbean Sea, Porifera, Symbiosis, ...5.0580

RELICT COPEPODS FROM LAKE TUBORG, ELLESMERE ISLAND ...Brackish Water, Canada, Carbon-14, Lakes, Plankton Sampling, ...5.0388

LIFE HISTORY OF THE SHARK COPEPOD, KROYERIA DISPAR ...Developmental Physiology, Ectoparasites, Life History Studies, Whole Body Culture & Rearing, ...5.0393

DEVELOPMENT OF CULTURE METHODS FOR ECOLOGICALLY IMPORTANT MARINE ZOOPLANKTON SPECIES ...Aquatic Ecology, Environmental Physiology, Invertebrate Culture, Zooplankton, ...5.0834

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON ...Oxygen, Water Salinity, Water Temperature-non-specific, Zooplankton, ...5.0835

Crabs

CONTROLLED ENVIRONMENTAL FACTORS ON THE DEVELOPMENT OF ESTUARINE AND OCEANIC CRUSTACEA ...Aquatic Ecology, Developmental Physiology, Estuaries, Salinity, Temperature, ...5.0476

PHYSIOLOGICAL MECHANISMS UNDERLYING THE BEHAVIOR OF MARINE CRUSTACEA ...Behavior, Behavioral Ecology, Shrimps - Common, ...5.0428

PORCELLANID CRABS OF AUSTRALIA ...Australia, Collections, Museum, Nomenclature, Classification, ...5.0354

VISUAL AND ACOUSTICAL COMMUNICATION IN CERTAIN MARINE CRUSTACEANS ...Atlantic Ocean-north, Auditory, Behavior, Visual Organs, ...5.0430

SYSTEMATIC STUDIES ON HERMIT CRABS AND OTHER DECAPOD CRUSTACEANS ...Animal Taxonomy, Atlantic Ocean-south, Developmental Physiology, Life History Studies, ...5.0408

EXPERIMENTAL MANIPULATION OF MECHANICAL AND PHYSIOLOGICAL RHYTHMS - A DUAL APPROACH TO THE BIOLOGICAL CLOCK PROBLEM ...Acetabularia, Behavioral Ecology, Biological Rhythms, Perching Birds - Songbirds, ...5.1002

GAMETOGENESIS AND FERTILIZATION IN THE BLUE CRAB, CALLINECTES SAPIDUS RATHBUN, AND OTHER CRABS ...Electron Microscopy, Histochemistry - Cytochem, Reproductive System, Structural Functions, ...5.0478

NEUROENDOCRINE PATHWAYS IN OSMOREGULATION IN CRUSTACEANS ...Aquatic Ecology, Endocrine System, Environmental Physiology, Osmoregulation, Shrimps - Common, ...5.0427

CALORIC STUDIES OF SPARTINA AND THE MARSH CRAB SESARMA RETICULATUM ...Calorimetry, Chlorideae (non-specific & Ot), Energy Budgets, Swamps-marshes, ...5.0380

CONTROLLED REARING OF DUNGENESS CRAB LARVAE ...Captive Rearing, Developmental Physiology, Maturity & Growth Stages, Oregon, ...5.0486

PORT SAMPLING - CRESENT CITY, BROOKINGS, PORT ORFORD ...Fish -non-specific, Life History Studies, Nets, Shrimps - Common, ...5.0356

KING CRAB SAMPLING GEAR STUDY ...Alaska, Censusing, Fishing Gear, Population Dynamics, Spawning & Nesting Sites, ...8.0113

DUNGENESS CRAB POPULATION DYNAMICS STUDY ...Alaska, Life History Studies, Population Dynamics, Tags, ...5.0346

SHELLFISH AND BOTTOMFISH DATA ...Commercial Fishing, Fish -other, Legislation, Shrimps - Common, ...5.0357

EVALUATE THE RESEARCH TECHNIQUES WHICH WILL BE EMPLOYED TO STUDY THE BASIC LIFE HISTORY OF THE RED CRAB (GERYON QUINQUEDENS) ...Age, Mark, Tag Or Capture -other, Maturity & Growth Stages, Size, ...5.0494

EFFECTS OF LOG RAFTING ON DUNGENESS CRAB ...Contamination - Water, Diving and Scuba, Forestry, Mans Activities, Pulp, Paper , and Logging, ...5.0347

SHELLFISHERIES RESEARCH ...Clams, Commercial Fishing, Life History Studies, Number Or Density, Oysters, ...5.0383

EFFECTS OF MARSH MANAGEMENT STRUCTURES UPON FISHES ...Alewife,menhaden,shad,herring, Engineering Structures-general, Land Use, Shrimps - Common, Spawning & Nesting Sites, Swamps-marshes, ...5.0206

ECOLOGICAL STUDIES OF THE BLUE CRAB, CALLINECTES SAPIDUS ...Aquatic Ecology, Estuaries, Life History Studies, Louisiana, ...5.0433

MANAGEMENT OF OREGON DUNGENESS CRAB RESOURCE ...Commercial Fishing, Legislation, Life History Studies, Oregon, Tags, ...5.0489

SURVIVAL REQUIREMENTS OF JUVENILE AND ADULT BLUE CRABS ...Biological Rhythms, Environmental Physiology, Maturity & Growth Stages, Osmoregulation, Salinity, Size, ...5.0475

EFFECT OF ENVIRONMENTAL CHANGES ON BLUE CRAB ABUNDANCE ...Environmental Ecology, Life History Studies, Migration, Number Or Density, Population Dynamics, ...5.0473

GULF-PENINSULA KING CRAB STUDIES ...Commercial Fishing, Gulf of Alaska, Habitat Studies, Population Dynamics, ...5.0342

BERING SEA KING CRAB STUDIES ...Bering Sea, Commercial Fishing, Environmental Ecology, Migration, ...5.0341

EARLY LIFE HISTORY DECAPOD CRUSTACEANS ...Animal Distr. (non-specific), Environmental Ecology, Life History Studies, Reproductive System, Shrimps - Common, ...5.0343

PARASITOLOGY ...Ciliates, Oysters, Pathology, Protozoa, Protozoa -other, ...5.0440

REARING AND SENSITIVITY STUDIES OF VARIOUS LIFE STAGES OF MARINE MACROINVERTEBRATES ...Bioindicators, Shrimps - Common, Whole Body Culture & Rearing, ...5.0496

LARVAL DEVELOPMENT OF DECAPOD CRUSTACEA ...Animal Taxonomy, Basic Embryology, Bibliography, Decapoda - Non-specific, Lobsters, ...5.0410

NUTRIENT STORES IN REPRODUCTION IN SEA INVERTEBRATES ...Decapoda -other, Invertebrate Nutrition, Reproductive System, Starfishes, ...5.0949

MECHANISMS OF VENTILATORY CONTROL ...Invertebrate Physiology, Nervous System, Respiratory System, ...5.0471

EXCITATION-CONTRACTION COUPLING IN MUSCLE ...Contraction and Relaxation, Lobsters, Musculoskeletal System, Plasma Membrane, ...5.0438

Crayfish

CULTURE OF RED SWAMP CRAWFISH, PROCAMBARUS CLARKI, IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Aquatic Ecology, Brackish Water, Captive Rearing, ...5.0432

Crustacea -non-specific

MID-DEPTH BIOLUMINESCENCE ...Bioluminescence, Vertical Distribution, ...1.0162

A STUDY OF THE ECOLOGY OF THE MICROFAUNA LIVING BETWEEN INTERTIDAL MARINE SEDIMENTS ...Beach, Copepods, Intertidal Areas, New England Province, Salinity, ...5.0793

NUTRITIONAL STUDIES ON MARINE ORGANISMS ...Invertebrate Nutrition, Nutrition Studies, Organics, Phytoplankton, ...5.1001

ECOLOGICAL, EXPERIMENTAL AND COMPUTER STUDIES OF ENDOGENOUS RHYTHMICITY ...Biological Rhythms, Brain, Computer Methods -general, Locomotion, ...5.0361

NEUROENDOCRINE REGULATION ...Brain, Endocrine System, Osmoregulation, Sodium, Water, ...5.0426

SHELLFISH EMBRYOLOGY AND LARVAE DEVELOPMENT STUDY ...Basic Embryology, Captive Rearing, Mollusks -non-specific & Other, Training Grants, Fellowships, ...5.0358

FISH POPULATIONS OF AMERICAN SAMOA ...American Samoa, Fish -non-specific, Fishing Gear, Number Or Density, ...5.0033

SHELLFISHERIES ...Censusing, Commercial Fishing, Legislation, Mollusks -non-specific & Other, ...4.0012

CRUSTACEAN COLLECTION OF EAST COAST OF UNITED STATES ...Atlantic Ocean-north, Collections, Estuaries, North Carolina, ...5.0481

ABYSSAL AND BATHYAL SYNOPIIDAE OF WORLD ...Abyssal, Animal Taxonomy, Bathyal, Vertical Distribution, World Wide, ...5.0384

ATLAS OF MARINE FAUNA ...Atlantic Ocean-north, Fish -non-specific, Handbooks, Mollusks -non-specific & Other, ...5.0101

PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE UPPER CHESAPEAKE BAY ...Chemical-general, Chesapeake Bay, Environmental Ecology, Mollusks -non-specific & Other, Physical-general, ...1.0150

MARINE BIOLOGICAL ASSESSMENT OF POLLUTIONAL FATE ...Contamination - Water, Fish -non-specific, Nets, Pollution - Effects of , ...6.0176

NEUROSECRETION AND ENDOCRINE PHYSIOLOGY ...Configuration, Diabetogenic, Ns, Endocrine System, Hormones, Intermedin, ...5.1023

THE STRUCTURE AND FUNCTION OF CRUSTACEAN EYES ...Invertebrate Anatomy, Light -other, Oceanic - Pelagic, Vertical Distribution, Visual Organs, ...5.0363

Decapoda - Non-specific

LARVAL DEVELOPMENT OF DECAPOD CRUSTACEA ...Animal Taxonomy, Basic Embryology, Bibliography, Crabs, Lobsters, ...5.0410

Decapoda -other

NUTRIENT STORES IN REPRODUCTION IN SEA INVERTEBRATES ...Crabs, Invertebrate Nutrition, Reproductive System, Starfishes, ...5.0949

Isopods

ECOLOGICAL AND EVOLUTIONARY IMPLICATIONS OF THE ECOTYPES OF ESTUARINE CRUSTACEA ...Classical, Estuaries, Invertebrate Anatomy, Metabolism, Productivity - Food Chain, ...5.0418

RELATIONSHIPS AMONG POPULATIONS OF LIMNORIA TRIPUNCTATA ...Animal Taxonomy, Population Dynamics, Reproductive System, ...5.0477

REPRODUCTIVE RELATIONSHIPS AMONG POPULATIONS OF A MARINE WOOD-BORING ISOPOD ...Animal Taxonomy, Invertebrate Anatomy, Population Dynamics, Reproductive System, ...**5.0414**

THE EPICARIDEA OF THE EASTERN PACIFIC ...Animal Taxonomy, Pacific Ocean-east, ...**5.0353**

EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE ...Creosote, Fouling, Petroleum Cpds. -non-specific, Preservatives, Wax, Paraffin, Wood Preservatives-non-specif, ...**8.0198**

Lobsters

LARVAL DEVELOPMENT OF SCYLLARIDEAN LOBSTERS ...Animal Taxonomy, Developmental Physiology, Environmental Physiology, Invertebrate Nutrition, Laboratory, ...**5.0409**

MANAGEMENT INVESTIGATIONS OF TWO SPECIES OF SPINY LOBSTERS PANULIRUS JAPONICUS AND P. PENICILLATUS ...Captive Rearing, Commercial Fishing, Management -other, Tags, ...**5.0422**

LARVAL STUDY OF THE LOBSTER ...Atlantic Ocean-north, Habitat Studies, Long Island Sound, Mark, Tag Or Capture - other, Maturity & Growth Stages, Plankton Sampling, ...**5.0371**

COASTAL LOBSTER FISHERY ...Censusing, Commercial Fishing, Legislation, Massachusetts, ...**5.0452**

OFFSHORE LOBSTER FISHERY ...Censusing, Commercial Fishing, Massachusetts, Nets, ...**5.0453**

POPULATION STRUCTURE OF THE LOBSTER ...Commercial Fishing, Diving and Scuba, Long Island Sound, Population Dynamics, Size, ...**5.0688**

TAGGING PROGRAM ...Long Island Sound, Number Or Density, Population Dynamics, Tags, Temporal Distribution, ...**5.0372**

NEPHROPID LOBSTERS OF THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean-north, Collections, ...**5.0396**

LOBSTER RESEARCH ...Commercial Fishing, Environmental Ecology, Habitat Studies, Population Dynamics, ...**5.0436**

LARVAL DEVELOPMENT OF DECAPOD CRUSTACEA ...Animal Taxonomy, Basic Embryology, Bibliography, Crabs, Decapoda - Non-specific, ...**5.0410**

EXCITATION-CONTRACTION COUPLING IN MUSCLE ...Contraction and Relaxation, Crabs, Musculoskeletal System, Plasma Membrane, ...**5.0438**

Shrimp - Amphipods

POPULATION STUDIES OF HAUSTORIIDAE AND GAMMARIDAE FROM NEW ENGLAND AND ON INFAUNAL AND EPIFAUNAL MARINE AMPHIPODS AT ENIWETOK ...Atolls, Habitat Studies, Micronesia, Population Dynamics, ...**5.0466**

SYSTEMATICS OF THE ANTARCTIC AND SUBANTARCTIC GAMMARIDEAN AMPHIPODA ...Abyssal, Animal Taxonomy, Antarctic Ocean, Bathyal, Vertical Distribution, ...**5.0359**

INFAUNA OF LOWER CHESAPEAKE BAY ...Aquatic Ecology, Chesapeake Bay, Population Dynamics, Streams, Virginia, ...**5.0661**

HYPERIID AMPHIPODS FROM THE GULF OF GUINEA ...Animal Taxonomy, Collections, Guinea, Oceanography-general, Vertical Distribution, ...**5.0387**

Shrimps - Brine Or Fairy

AN ANALYSIS OF DEVELOPMENT IN ARTEMIA SALINA EMBRYOS ...Basic Embryology, Biosynthesis, Nucleic Acids, Proteins, Ribosomes, ...**5.0406**

GENETIC REGULATION OF HEMOGLOBIN SYNTHESIS IN ARTEMIA ...Environmental Physiology, Hemoglobin, Marker, Mutagens, ...**5.0365**

Shrimps - Common

PHYSIOLOGICAL MECHANISMS UNDERLYING THE BEHAVIOR OF MARINE CRUSTACEA ...Behavior, Behavioral Ecology, Crabs, ...**5.0428**

THE ALPHEID SHRIMP OF AUSTRALIA ...Animal Taxonomy, Australia, Collections, Pubilications -other, ...**5.0425**

TEMPERATURE AND SALINITY TOLERANCE OF THE SAND SHRIMP, CRANGON SEPTEMSPINSOA ...Environment Resistance, Environmental Physiology, Estuaries, Salinity, Temperature, ...**5.0437**

NEUROENDOCRINE PATHWAYS IN OSMOREGULATION IN CRUSTACEANS ...Aquatic Ecology, Crabs, Endocrine System, Environmental Physiology, Osmoregulation, ...**5.0427**

SHRIMP PRODUCTION IN LOUISIANA SALT-MARSH IMPOUNDMENTS UNDER EXISTING AND MANAGED CONDITIONS ...Aquaculture & Fish-farming, Captive Rearing, Lagoons, Louisiana, Water Movement, Currents,, ...**5.0435**

STUDY ON THE DISTRIBUTION AND ABUNDANCE OF PINK SHRIMP, PANDALUS JORDANI, IN THE PACIFIC OCEAN OFF OREGON ...Censusing, Fishing Gear, Life History Studies, Pacific Ocean-general, Population Dynamics, ...**5.0487**

SEASONAL ABUNDANCE AND BIOLOGICAL STABILITY OF THE COMMERCIAL SHRIMP OF GEORGIA ...Commercial Fishing, Number Or Density, ...**5.0419**

PORT SAMPLING - CRESENT CITY, BROOKINGS, PORT ORFORD ...Crabs, Fish -non-specific, Life History Studies, Nets, ...**5.0356**

INVESTIGATION OF ECOLOGICAL FACTORS LIMITING PRODUCTION OF THE ALASKAN PANDALID SHRIMP ...Alaska, Commercial Fishing, Life History Studies, Nets, Vertical Distribution, ...**5.0345**

SHELLFISH AND BOTTOMFISH DATA ...Commercial Fishing, Crabs, Fish -other, Legislation, ...**5.0357**

LAKE BORGNO - CHANDELEUR SOUND SYSTEM ...Data Acquisition, Gulf of Mexico, Maturity & Growth Stages, Nets, Plankton Sampling, Population Dynamics, ...**5.0434**

COMPARATIVE BIOCHEMISTRY OF PROTEINS FROM GULF FISH ...Blood Proteins -non-specific, Drums, Gel Electrophoresis, Hemoglobin, ...**5.0326**

ENERGETICS OF PALAEMONETES PUGIO AND THE WEEDBED COMMUNITY OF SOUTH CREEK ESTUARY ...Aquatic Vegetation -ns, Energy Budgets, Estuaries, Habitat Studies, North Carolina, ...**5.0482**

EFFECTS OF MARSH MANAGEMENT STRUCTURES UPON FISHES ...Alewife,menhaden,shad,herring, Crabs, Engineering Structures-general, Land Use, Spawning & Nesting Sites, Swamps-marshes, ...**5.0206**

MARINE INVERTEBRATE EXPLORATIONS ...Commercial Fishing, Freshwater Mussels, Scallops, Pacific Ocean-general, Temporal Distribution, Vertical Distribution, ...**5.0733**

FISHES TAKEN INCIDENTAL TO SHRIMP TRAWLING ...Atlantic Ocean-south, Fish -non-specific, Nets, Number Or Density, ...**5.0072**

ADULT SHRIMP STUDIES ...Alaska, Bays, Biological Rhythms, Habitat Studies, Life History Studies, ...**5.0340**

EARLY LIFE HISTORY DECAPOD CRUSTACEANS ...Animal Distr. (non-specific), Crabs, Environmental Ecology, Life History Studies, Reproductive System, ...**5.0343**

CONTRIBUTIONS TO THE BIOLOGY OF THE ROYAL RED SHRIMP, HYMENOPENAEUS ROBUSTUS ...Atlantic Ocean-south, Maturity & Growth Stages, Number Or Density, Vertical Distribution, ...**5.0421**

EASTERN PACIFIC SHRIMPS OF THE GENUS PENAEUS ...Animal Taxonomy, Life History Studies, Pacific Ocean-general, Range Or Territorial Distr. , Vertical Distribution, ...**5.0403**

BENTHIC PENAEID SHRIMPS (OTHER THAN PENAEUS) FROM THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean-general, Collections, Continental Shelf, Vertical Distribution, ...**5.0404**

DIAGNOSTIC CHARACTERS & DEVELOPMENT OF EXTERNAL GENITALIA IN JUVENILE GROOVED SHRIMPS OF GENUS PENAEUS FROM WESTERN ATLANTIC ...Atlantic Ocean-general, Developmental Physiology, Invertebrate Anatomy, Reproductive System, ...**5.0405**

CIRCULATION DYNAMICS (GULF OCEANOGRAPHY PROGRAM) ...Circulation-general, Environmental Changes, Gulf of Mexico, Thermodynamics, ...**2.0045**

PREDICTING COMMERCIAL SHRIMP ABUNDANCE (SHRIMP DYNAMICS PROGRAM) ...Bays, Behavioral Ecology, Commercial Fishing, Environmental Ecology, Population Dynamics, ...**5.0499**

131.116B - LARVAL CULTURE (SHRIMP AQUACULTURE PROGRAM) ...Algal Culture, Aquaculture & Fish-farming, Captive Rearing, Environmental Physiology, Food Supply, ...**5.0500**

EXPERIMENTAL SEEDING (SHRIMP AQUACULTURE PROGRAM) ...Captive Rearing, Florida, Population Dynamics, Spawning & Nesting Sites, Stocking of Fish & Shellfish, ...**5.0501**

RECONNAISSANCE ECOLOGIC SURVEY OF THE CONTINENTAL SHELF AND UPPER SLOPE (GULF OCEANOGRAPHY PROGRAM) ...Behavioral Ecology, Biology, Continental Shelf, Environmental Ecology, Migration, Population Dynamics, ...**5.0502**

BIOLOGICAL OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM) ...Environmental Ecology, Food Supply, Gulf of Mexico, Productivity - Food Chain, ...**5.0838**

POPULATION DYNAMICS (SHRIMP DYNAMICS PROGRAM) ...Commercial Fishing, Gulf of Mexico, Mortality Rates, Nets, Population Dynamics, ...**5.0503**

JUVENILE AND ADULT CULTURE (SHRIMP AQUACULTURE PROGRAM) ...Aquaculture & Fish-farming, Captive Rearing, Growth Rate, Ponds, ...**5.0504**

FOOD AND EXPERIMENTAL ENVIRONMENTS (SHRIMP AQUACULTURE PROGRAM) ...Aquaculture & Fish-farming, Captive Rearing, Digestive System, Food Supply, Water Environment -other, ...**5.0505**

LOCAL FISHERY SYSTEMS DEVELOPMENT ...California, Commercial Fishing, Sharks, Swordfish, ...**5.0198**

NORTHERN SHRIMP EXPLORATIONS ...Atlantic Ocean-north, Censusing, Commercial Fishing, Fishing Gear, ...**5.0457**

REARING AND SENSITIVITY STUDIES OF VARIOUS LIFE STAGES OF MARINE MACROINVERTEBRATES ...Bioindicators, Crabs, Whole Body Culture & Rearing, ...**5.0496**

Shrimps - Mantis...

STOMATOPOD CRUSTACEA FROM THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean-general, ...**5.0395**

STOMATOPOD CRUSTACEA OF THE EASTERN PACIFIC REGION ...Animal Taxonomy, Atlantic Ocean-general, Pacific Ocean-east, ...**5.0397**

Shrimps - Seed Or Mussel

THE OSTRACODA OF THE BAY OF NAPLES ...Environmental Ecology, Invertebrate Anatomy, Italy, Life History Studies, Nomenclature, Classification, ...**5.0415**

A SYSTEMATIC STUDY OF ENTOCYTHERID OSTRACODS ...Animal Taxonomy, Madagascar-malagasy Republic, New Zealand, Pubilications -other, South America, ...**5.0492**

TAXONOMY AND ECOLOGY OF NEARSHORE MARINE OSTRACODA ...Animal Taxonomy, Biofacies, Class Ostracoda, Ecological, Environmental Ecology, Paleoenvironments, ...**5.0707**

NORTH AMERICAN POST-OLIGOCENE CYTHERID OSTRACODS ...Animal Taxonomy, Invertebrate Anatomy, Life History Studies, Nearctic, Phylogenies, ...**7.0179**

OSTRACODA OF THE INDIAN OCEAN ...Animal Taxonomy, Biogenous, Indian Ocean-general, Quaternary Period, ...**5.0385**

ABYSSAL OSTRACODES OF THE WORLD ...Abyssal, Core Analysis, Vertical Distribution, World Wide, ...**5.0386**

SYSTEMATIC STUDY OF MYODOCOPID OSTRACODS OF THE INDIAN OCEAN ...Animal Taxonomy, Collections, Expeditions, Indian Ocean-general, ...**5.0394**

Crystal Structure

Non Specific

EFFECT OF PRESSURE ON MATERIALS ...High Pressure Research, High Temperature Research, ...**8.0211**

Culture (methods & Techniques)

Algal Culture

STUDIES WITH TROPICAL AND SUBTROPICAL MICROALGAE ...Benthic Flora, Continental Shelf, Primary Productivity, Sub - Tropic, Tropic, ...**5.0693**

EFFECTS OF DEPTH ON GROWTH AND REPRODUCTION OF BENTHIC MARINE ALGAE ...Depth, Growth and Differentiation, Phaeophyta (non-specific & Ot), Reproductive Physiology, Rhodophyta (non-specific & Ot), ...**5.0684**

MARINE PHYTOPLANKTON RESEARCH ...Indian Ocean-general, Nutrition Studies, Pacific Ocean-general, Phytoplankton, Symbiosis, ...**5.0847**

STUDIES OF THE EFFECTS OF NUTRIENTS ON THE GROWTH OF PHYTOPLANKTON IN THE TROPICAL PAC. OCEAN ...Growth Rate, Nutrition, Pacific Ocean-general, Phytoplankton, Tropic, ...**5.0948**

STUDIES OF THE PHAEOPHYCEAN ORDERS CHORDARIALES AND PUNCTARIALES ...Atlantic Ocean-north, Phaeophyta (non-specific & Ot), Range Or Territorial Distr. , Temporal Distribution, ...**5.0715**

PHYSIOLOGY AND ECOLOGY OF MARINE DIATOMS ...Algae- Diatoms, Habitat Studies, Marine Plants, Nutrition Studies, Physiological Ecology, Plant Taxonomy, ...**5.0735**

BIOLOGY AND PALEONTOLOGY OF MARINE DINOFLAGELLATES AND HYSTRICHOSPHERES ...Algae-Dinoflagellates, Cell Cycle, Plant Developmental Biology, Range Or Territorial Distr. , Spores, Vertical Distribution, ...**5.0799**

ECOLOGICAL STUDIES OF THE MARINE RED ALGA CHONDRUS CRISPUS STACKHOUSE ...Ag Uses of Nat. resource-other, Chondrus, Growth and Differentiation, Reproductive Physiology, ...**5.0710**

ORGANIC INFLUENCES ON CALCIUM CARBONATE CEMENTATION ...Algae- General, Biology, Cement Origin, Marine Plants, Secretions and Products, ...**5.0729**

THE STATUS AND POTENTIAL OF AQUACULTURE ...Aquaculture & Fish-farming, Fish -non-specific, Food Supply, Survey Studies, ...**8.0003**

LIGHT REQUIREMENTS FOR MARINE ALGAE ...Algae-General, Autotrophic, Light, Marine Plants, Pigments, ...**5.0703**

EXPERIMENTAL CULTURE OF CALCAREOUS GREEN ALGAE OF CORAL REEFS ...Biology, Calcium, Chlorophyceae (non-specif.&ot), Growth and Differentiation, Plant Taxonomy, Reefs, ...**5.0719**

ALGAE AS FOOD FOR MARINE INVERTEBRATE LARVAE HELD IN THE LABORATORY ...Bulk Culture -other, Chesapeake Bay, Invertebrate Nutrition, Invertebrates -non-specific, ...**5.0732**

PHYSIOLOGICAL AND BIOCHEMICAL REQUIREMENTS OF PHYTOPLANKTON SPECIES ...Marine Plants, Media, Nutrition Studies, Phytoplankton, Planktonic - Floating, ...**5.0995**

ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM) ...Algae- General, ...**5.0759**

SEASONAL VARIATIONS OF ALGAL POPULATIONS ...Algae- General, Nutrition Studies, Temporal Distribution, ...**5.0705**

NUTRIENT REQUIREMENTS OF ALGAE ...Cyanophyta (non-specific & Ot), Nitrate, Nitrite, Nutrition Studies, Phosphate, Phosphite, ...**5.0706**

131.116B - LARVAL CULTURE (SHRIMP AQUACULTURE PROGRAM) ...Aquaculture & Fish-farming, Captive Rearing, Environmental Physiology, Food Supply, Shrimps - Common, ...**5.0500**

PLANKTON REARING, ENVIRONMENTAL REQUIREMENTS AND SENSITIVITY STUDIES ...Bioindicators, Great Lakes-general, Microbiological Analysis, Plankton (non-specific), Water Quality-general, ...**5.0804**

INTEGRATED FIELD AND LABORATORY SYSTEM FOR ASSAYING THE EFFECTS OF POLLUTANTS AND TOXICANTS UPON WATER QUALITY ...Axenic Culture, Phytoplankton, Pollution - Effects of , Responses to Growth, ...**5.0831**

DEVELOPMENT OF A METHOD FOR CHRONIC TOXICITY BIOASSAY USING MARINE PLANKTONIC ALGAE ...Bioassays, Marine Plants, Microbiological Analysis, Monitoring (long Term Studies), Phytoplankton, Technique Development, Toxicology, ...**5.0726**

MEASUREMENT OF THE RATE OF CARBON DIOXIDE (C14) FIXATION INTO SUBCELLULAR FRACTIONS OF ALGAE ...Algae- General, Bioindicators, Carbon, Carbon Dioxide Fixation, Growth Rate, Intracellular Localization, ...**5.0728**

LABORATORY STUDIES OF TOXIC DINOFLAGELLATES ...Algal Toxins, Gonyaulax, Gulf of Mexico, Gymnodinium, Plant Origin, ...**5.0837**

COMPARATIVE STUDIES OF DINOFLAGELLATE TOXINS ...Algae- Dinoflagellates, Algal Toxins, Cellular Physiology, Toxicology, ...**6.0121**

Axenic Culture

A NEW APPROACH TO NUTRITION, PHYSIOLOGY, AND MINERAL CYCLING OF FORAMINIFERA ...Foraminifera, Invertebrate Nutrition, Metabolism, Productivity - Food Chain, ...**5.0809**

PROTOZOOLOGY ...Animal Taxonomy, Histology and Cytology, Invertebrate Nutrition, Protozoa, ...**5.0443**

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT MARINE

PHYTOPLANKTON SPECIES ...Growth and Differentiation, Marine Biology, Marine Plants, Phytoplankton, Responses to Growth, ...5.0833

INTEGRATED FIELD AND LABORATORY SYSTEM FOR ASSAYING THE EFFECTS OF POLLUTANTS AND TOXICANTS UPON WATER QUALITY ...Algal Culture, Phytoplankton, Pollution - Effects of , Responses to Growth, ...5.0831

STUDY OF TOXIN SYNTHESIS IN PRYMNESIUM PARVUM ...Algal Toxins, Biosynthesis, Gonyaulax, Gymnodinium, Prymnesium, ...6.0124

Bacterial Culture

PHOTOSYNTHETIC BACTERIA ...Classification Or Taxonomy, Isolation From Nat. environ. , Marine Bacteria, Photosynthetic Bacteria, Sulfur Bacteria, ...5.0814

MARINE-BACTERIA CULTURE ...Biological, Fouling, Isolation From Nat. environ. , Marine Bacteria, Water Bacteria, ...5.0849

PHYSIOLOGICAL CHARACTERIZATION OF CERTAIN MARINE BACTERIA ...Bact. morphology (general), Biology, Isolation From Nat. environ. , Marine Bacteria, Metabolism (intracellular), Tissue Techniques, ...5.0784

DISTRIBUTION OF CL. BOTULINUM E. IN FISH, SHELLFISH AND THE AQUATIC ENVIRONMENT IN OREGON ...Clostridium Botulinum, Oregon, Range Or Territorial Distr. , Virulence and Pathogenicity, ...5.0822

NITRIFICATION BY MARINE MICROORGANISMS ...Autotrophic, Bact. morphology (general), Isolation From Nat. environ. , Marine Bacteria, Nitrogen Bacteria, Range Or Territorial Distr. , ...5.0800

Bulk Culture -other

ALGAE AS FOOD FOR MARINE INVERTEBRATE LARVAE HELD IN THE LABORATORY ...Algal Culture, Chesapeake Bay, Invertebrate Nutrition, Invertebrates -non-specific, ...5.0732

THE ENVIRONMENTAL REQUIREMENTS OF MARINE PLANKTONIC ORGANISMS ...Marine Biology (non-specific), pH -water, Plankton (non-specific), Water Salinity, Water Temperature -other, ...5.0921

Fungal Culture

COMPARATIVE BIOCHEMICAL AND MORPHOLOGICAL CHARACTERISTICS OF MARINE FUNGI FROM SHELLFISH ...Endoparasites -other, Histochemistry - Cytochem, Histology and Cytology, Marine Fungi (non-specific), Plant Taxonomy, ...5.0791

STUDIES ON THE DEVELOPMENT OF DERMOCYSTIDIUM MARINUM ...Cell Cycle, Control and Prevention, Dermocystidium, Oysters, Pathology, ...5.0836

Invertebrate Culture

ULTRASTRUCTURAL AND AUTORADIOGRAPHIC INVESTIGATION OF CALCIFICATION IN FORAMINIFERS ...Calcification, Calcium, Cell Wall, Cell. organ. & Organoids - ot, Foraminifera, Histology and Cytology, ...5.0788

ANNUAL PHYTOPLANKTON PRODUCTION IN PUGET SOUND WATERS ...Copepods, Phytoplankton, Puget Sound, Standing Crops, Tides, ...5.0931

REAR AND DESCRIBE LARVAE OF BIVALVES ...Captive Rearing, Clams, Developmental Physiology, Freshwater Mussels, Scallops, ...5.0507

DEVELOPMENT OF CULTURE METHODS FOR ECOLOGICALLY IMPORTANT MARINE ZOOPLANKTON SPECIES ...Aquatic Ecology, Copepods, Environmental Physiology, Zooplankton, ...5.0834

Monolayer Culture

TISSUE CULTURE - VIROLOGY ...Animal Viruses (non-specific), Bacteria (non-specific), Cell Injury and Autolysis, Marine Biology, Oysters, Tissues, ...5.0978

Organelle Culture

GROWTH AND DIFFERENTIATION OF PLASTIDS ...Acetabularia, Biosynthesis, Cytoplasmic Inheritance, DNA Other, Nucleus (non-specific & Ot.), Photosynthetically Active, ...5.0683

Suspension Culture

MECHANICAL PROPERTIES OF MAMMALIAN CELLS ...Blood Cells, Cellular Membranes (non-spec.), Flow Metering Techniques, Time-lapse Photography, ...5.0992

STUDIES ON EMBRYONIC CELLS ...Basic Embryology, Chickens, Reproductive System, Sea Squirts - Tunicates, ...5.0945

Currents-bottom

STUDY OF OCEAN CURRENTS AT SEA FLOOR AND THEIR SPACTIAL CORRELATION ...Benthonic-bottom, Field Characteristics, Water Motion Recorders, ...2.0003

OCEANOGRAPHY, PLEISTOCENE GEOLOGY AND SEDIMENTS OF LITTLE BAHAMA BANK ...British West Indies, Carbonates-general, Energy, Quaternary Period, Water Motion Recorders, ...7.0229

DEEP FLOW, WATER CHARACTERISTICS, TOPOGRAPHY AND SEDIMENTS IN THE CENTRAL PACIFIC AREA ...Abyssal, Distribution, Geomorphology-topography, Pacific Ocean-general, Structural Studies, Water Motion Recorders, ...7.0032

WATER MASSES, CURRENTS AND ORIGIN OF THE ATLANTIC BOTTOM WATER IN THE WEDDEL SEA, ANTARCTICA ...Depth, Oceanic Fronts, Salinity, Sampling, Temperature, Weddell Sea, ...4.0134

TURBULENT PROCESSES AT AIR-SEA AND BOTTOM BOUNDARIES OF THE OCEAN ...Thermal, Turbulence, Waves, Wind-water Interaction, ...3.0033

GLOBAL OCEAN FLOOR ANALYSIS ...Acoustical, Bathymetry, Benthonic-bottom, Geomorphology-topography, Seismic Studies, Subbottom, ...4.0046

DIVER-ASSISTED OCEANOGRAPHY ...Benthonic-bottom, Continental Shelf, Diving and Scuba, Geomorphology-topography, Mapping, Waves-internal, ...4.0098

Currents-longshore

AEGEAN SEA BIOLOGY ...Aegean Sea, Benthic Organisms (non-specif), Plankton (non-specific), Range Or Territorial Distr. , Temporal Distribution, ...5.0887

THE POTENTIAL SOURCE, TRANSPORT AND DEPOSITIONAL PATTERNS OF CLASTIC SEDIMENTS IN PORTIONS OF COASTAL GEORGIA ...Beach, General Mineralogic Properties, Georgia, Microstructure, Size, ...7.0235

RECENT SEDIMENTATION BY TIDAL AND LONGSHORE CURRENTS ON A CARBONATE BANK IN LOWER FLORIDA KEYS ...Banks, Florida, Quaternary Period, Sedimentation, Tides, ...7.0253

MECHANICS OF WAVE ACTION IN DEEP AND SHALLOW WATER ...Geomorphology-topography, Sand Bars, Tsunami, Waves, Waves-internal, ...2.0100

Currents-ocean

VISIBLE REGION INSTRUMENTATION FOR OCEANOGRAPHIC SATELLITES ...Geomorphology-topography, Mapping, Photography, Satellites, Shoals, ...8.0088

A STUDY OF THE DEEP CIRCULATION AND DEEP FISH POPULATIONS IN THE PACIFIC OCEAN ...Fish -non-specific, Pacific Ocean-general, Tides, Vertical Distribution, ...2.0005

NUCLEAR OCEANOGRAPHIC TECHNIQUES ...Isotope Dilution, Physical Properties, Radioactivity, Water Analysis, Water Motion Recorders, ...8.0087

OCEAN CIRCULATION STUDIES ...Acoustical, Atlantic Ocean-north, Hydrodynamics, Statistics-general, Water Motion Recorders, Waves-internal, ...2.0040

OCEAN WAVES AND TIDES ...Subsurface Environments, Thermal, Tides, Water Motion Recorders, Waves, ...2.0080

CIRCULATION STUDIES ...Circulation-general, Gulf of Mexico, Hydrodynamics, Mixing, Pacific Ocean-east, ...2.0042

ARCTIC RESEARCH ...Acoustical, Arctic Ocean, Geomorphology-topography, Magnetic Studies, Sea Ice, ...4.0049

AIR-SEA INTERACTION ...Air-sea Boundary-general, Gulf of Mexico, Thermal, Tropical Cyclones, Weather Forecasting, ...3.0042

LONG RANGE SOFAR FLOATS ...Acoustical, Physical Analysis, Subsurface Environments, Water Motion, Water Motion Recorders, ...2.0025

INERTIAL TECHNIQUES ...Acoustical, Hydrodynamics, Physical Analysis, ...**8.0099**
OPTICAL MEASUREMENTS ...Benthonic-bottom, Optical, Photography, Subsurface Environments, ...**1.0170**
INDUCTION IN THE OCEAN ...Crust, Earth Interior, Fluctuations, Induction, Oceanic Fronts, ...**1.0137**
DESCRIPTIVE OCEANOGRAPHY ...Circulation-general, Data Analysis - General, Pacific Ocean-east, Wind-water Interaction, ...**4.0116**
WAVE, CURRENT AND STORM SURGE RESPONSE TO EXTREME WIND CONDITIONS ...Forecasting-prediction, Model Studies, Storms-general, Waves, Wind-water Interaction, ...**2.0107**
TRITIUM AS A TRACER FOR MIXING PROCESSES ...Mixing, Radioactivity-general, Salinity, Tracers, Tritium, ...**2.0053**
ANTARCTIC PHYSICAL OCEANOGRAPHY ...Antarctic Ocean, Depth, Photography, Salinity, Temperature, ...**4.0133**
TIME FLUCTUATIONS IN OCEAN CURRENTS ...Geomorphology-topography, Model Studies, Testing of Models, Waves, ...**2.0039**
THEORY OF LARGE-SCALE ATMOSPHERIC AND OCEANIC PROCESSES ...Circulation-general, Model Studies, Tropic, Weather Forecasting, Wind-water Interaction, ...**2.0070**
CURRENTS AND WATER MASSES IN THE SOUTHWEST ATLANTIC ...Circulation-general, Oceanic Fronts, Subsurface Environments, ...**2.0041**
(U) OCEAN CIRCULATION MODELS ...Circulation-general, Model Studies, Shear, Waves, Wind-water Interaction, ...**2.0024**

DYNAMICS OF MOORED BUOY SYSTEMS USED IN OCEANOGRAPHY R&D AND SURVEILLANCE ...Buoys, Laboratory Analysis, Model Studies, Moorings, Waves, ...**8.0321**
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PUERTO RICO COOP - MONA PASSAGE ...Continental Shelves, Land Economics, Mine Wastes, Potential of Deposit, Puerto Rico, Sands and Gravels, ...7.0034

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DEVELOPMENT OF DIAMOND DRILLING TECHNIQUES, FOR PHOSPHORITE DEPOSITS, USING STANDARD TOOLS PLUS BUOYANCY TANKS ...Bottom Sampling Device, Disturbed/undisturbed, Drilling and Coring, Soil Sampling, Technique Development, ...8.0248

ANALYSIS AND INTERPRETATION OF DATA FROM GEOPHYSICAL AND PHOTOGRAB SURVEY OF CORONADO BANK, OFF SOUTHERN CALIFORNIA ...California, Ocean Mining, Photography, Potential of Deposit, ...7.0004

Sands and Gravels

POTENTIALLY-ECONOMIC SAND AND SILT DEPOSITS IN LAKE ONTARIO, NEW YORK ...Geologic Maps, Lake Ontario, New York, Potential of Deposit, Submergent, ...7.0024

PUERTO RICO COOP - MONA PASSAGE ...Continental Shelves, Land Economics, Mine Wastes, Oil - Petroleum, Potential of Deposit, Puerto Rico, ...7.0034

Deposits-ores

MARINE HEAVY-METALS PRODUCTION INFORMATION, ON WORLDWIDE BASIS ...Appraisals-general, Beneficiation, Documents & Literature, Heavy Elements, Ocean Mining, ...7.0006

OREGON-NORTHERN CALIFORNIA PLACER DEPOSITS ...California, Drilling and Coring, Oregon, Placer, Reconnaissance, ...7.0009

Cobalt

FORMATION AND DEGRADATION OF MANGANESE NODULES BY MARINE BACTERIA ...Manganese, Marine Bacteria, Nickel, Ocean Mining, Titanium, ...7.0025

Gold

APPLICATION OF NUCLEAR TECHNIQUES TO MARINE MINERALS TECHNOLOGY ...Activation Analysis, Geological Exploration, Manganese, Ocean Mining, Physical Properties, ...8.0085

MARINE GEOLOGY OF THE SAN FRANCISCO BAY ...Bays, Geology-general, Mechanical Properties, San Francisco Bay, Structural Studies, Tectogenesis, ...7.0035

LABORATORY STUDIES TO CORRELATE ENGINEERING PROPERTIES OF MARINE PLACER MATERIALS WITH SAMPLING TOOL PERFORMANCE ...Coring and Dredging, Laboratory Analysis, Mechanical Properties, Placer, Scientific-service-support, ...8.0244

Manganese

APPLICATION OF NUCLEAR TECHNIQUES TO MARINE MINERALS TECHNOLOGY ...Activation Analysis, Geological Exploration, Gold, Ocean Mining, Physical Properties, ...8.0085

FORMATION AND DEGRADATION OF MANGANESE NODULES BY MARINE BACTERIA ...Cobalt, Marine Bacteria, Nickel, Ocean Mining, Titanium, ...7.0025

Nickel

FORMATION AND DEGRADATION OF MANGANESE NODULES BY MARINE BACTERIA ...Cobalt, Manganese, Marine Bacteria, Ocean Mining, Titanium, ...7.0025

Silver

A STUDY OF THE LEAD OXYCHLORIDES AND RELATED SPECIES FOUND IN THE ANCIENT SLAGS OF LAURIUM, GREECE ...Chemical Reactions, Discriptions of Minerals, Greece, Mine Wastes, Mineral Genesis, ...7.0058

Titanium

FORMATION AND DEGRADATION OF MANGANESE NODULES BY MARINE BACTERIA ...Cobalt, Manganese, Marine Bacteria, Nickel, Ocean Mining, ...7.0025

Deserts

A UNIFIED APPROACH TO WATER, FOOD AND POWER IN A COASTAL DESERT COMMUNITY ...Arid and Desert, Desalination, Diesel, Distilling Units, Electric Power Plants, Greenhouse, Use of Impaired Water, ...7.0002

Detectors and Sensors

OCEAN RADIOACTIVITY ...Depth, Neutron Detectors, Proportional Counters, Radioactivity, ...1.0089

Deuterium

LIGHT ISOTOPE STUDIES ...Chemical Reactions, Circulation-general, Isotope Tracer-other, Mixing, Oxygen, Particle-gas Transfer, ...1.0077

Developmental Biology - Animal

GRADUATE SUMMER RESEARCH PROGRAMS IN EXPERIMENTAL EMBRYOLOGY ...Bermuda , Facilities, Marine Biology (non-specific), ...11.0002

ULTRASTRUCTURE OF VARIOUS MARINE AND BRACKISH WATER ORGANISMS ...Differentiation Mechanism, Electron Microscopy, Marine Biology (non-specific), Plant Developmental Biology, ...5.0640

Invertebrates

Basic Embryology

BIOSYNTHETIC PROCESSES DURING DEVELOPMENT OF SEA URCHIN EGGS ...Cell Cycle, Messenger RNA , Nucleic Acids, Proteins, Sea Urchins & Other Echinoderm, ...5.0775

MOLECULAR ASPECTS OF CELLULAR DIFFERENTIATION AND DIVISION ...Biosynthesis, Cell Cycle, Differentiation Mechanism, Proteins, Replication, Sea Urchins & Other Echinoderm, ...5.0985

MECHANISMS OF CYTOKINESIS IN ANIMAL CELLS ...Cell Cycle, ...5.1008

DEVELOPMENT IN ILYANASSA ...Gastropods - slugs,conch,snails, Metabolic Inhibitors, Other, ...5.0594

CYTOLOGICAL CHARACTERISTIC ...Animal Taxonomy, Porifera, Speciation, Structural Functions, ...5.0557

BIOCHEMISTRY OF FERTILIZATION AND EARLY DEVELOPMENT ...Fertilization, Reproductive System, Sea Urchins & Other Echinoderm, Vertebrates -non-specific, ...5.0550

MACROMOLECULAR EVENTS OF FERTILIZATION AND EARLY EMBRYONIC DEVELOPMENT ...Biosynthesis, Reproductive System, Ribosomes, Sea Urchins & Other Echinoderm, ...5.1011

PHYSIOLOGY OF FERTILIZATION AND NUCLEO-CYTOPLASMIC INTERACTIONS IN SEA URCHIN DEVELOPMENT ...Messenger RNA , Nucleus (non-specific & Ot.), Reproductive System, Sea Urchins & Other Echinoderm, Selection & Breeding, ...5.0673

STUDIES ON GAMETOGENESIS IN HYDROMEDUSAE ...Developmental Physiology, Differentiation Mechanism, Hydra, Portuguese Man-of-war, Regeneration and Wound, Reproductive System, Testosterone, ...5.1040

CYTOPLASMIC FILAMENTS AND CELL MOVEMENT IN DEVELOPMENT ...Fibrils and Filaments, Growth (non-specific & Ot.), Motility and Migration, Proteins, Sea Squirts - Tunicates, ...5.1037

CELL CONTACT IN RELATION TO GROWTH AND MORPHOGENESIS ...Adhesion, Cellular Membranes (non-spec.), Electron Microscopy, Porifera, ...5.0996

FERTILIZATION MECHANISMS AND GAMETE PHYSIOLOGY IN MARINE INVERTEBRATES ...Male Gametes, Metabolism, Reproductive System, Sea Urchins & Other Echinoderm, ...5.0590

STRUCTURE AND FUNCTION OF CELL ORGANELLES DURING GROWTH AND DEVELOPMENT ...Acrosomes, Differentiation Mechanism, Nucleolus, Ribosomes, ...5.0935

STUDIES ON EMBRYONIC CELLS ...Chickens, Reproductive System, Sea Squirts - Tunicates, Suspension Culture, ...5.0945

REPRODUCTION AND EMBRYONIC SURVIVAL IN ASCIDIA NIGRA (SAVIGNY) ...Biological Rhythms, Laboratory, Reproductive System, Sea Squirts - Tunicates, Whole Body Culture & Rearing, ...5.0600

MOLECULAR STUDIES OF DIFFERENTIATING CELLS ...Biosynthesis, Differentiation Mechanism, ...5.0984

NUCLEIC ACID AND PROTEIN SYNTHESIS DURING OOGENESIS ...Autoradiography, Gastropods - slugs,conch,snails, Gene Action, Lugworms, Marine Segmented-worm, Reproductive System, ...5.1024

RNA SYNTHESIS DURING SEA URCHIN DEVELOPMENT ...Differentiation Mechanism, Metabolic-biochemical Genetics, Mitochondria, Replication, Sea Urchins & Other Echinoderm, ...5.0611

GROWTH, DIFFERENTIATION AND NERVE TRANSMISSION IN THE HYDROID, CAMPANULARIA ...Developmental Physiology, Growth Rate, Hydra, Portuguese Man-of-war, Nervous System, ...5.0601

BIOCHEMISTRY OF DEVELOPMENT ...Control and Regulation, Differentiation Mechanism, Messenger RNA , Sea Urchins & Other Echinoderm, Tryptophan Oxidase, ...5.0994

PRESENCE OF ENZYMES RELATED TO DNA SYNTHESIS IN EGGS OF ECHINODERMS ...Developmental Stages, DNA

Polymerase, Enzyme Formation, Nucleoside Kinase, Sea Urchins & Other Echinoderm, ...**5.1034**

CONTINUED STUDIES ON THE INFLUENCE OF THE EGG CORTEX ON THE DEVELOPMENT OF THE MOLLUSCAN EMBRYO ...Differentiation Mechanism, Gastropods - slugs,conch,snails, Octopus, Squid, Cuttlefish... , Plasma Membrane, Surface Properties -other, ...**5.0423**

SHELLFISH EMBRYOLOGY AND LARVAE DEVELOPMENT STUDY ...Captive Rearing, Crustacea -non-specific, Mollusks - non-specific & Other, Training Grants, Fellowships, ...**5.0358**

MORPHOLOGY, PHYSIOLOGY AND ECOLOGY OF MARINE LAMELLIBRANCHS ...Aquatic Ecology, Behavior, Freshwater Mussels, Scallops, Invertebrate Anatomy, ...**5.0479**

CILIA DIFFERENTIATION IN THE SEA URCHIN EMBRYO ...Cilia and Flagella, Differentiation Mechanism, Proteins, Sea Urchins & Other Echinoderm, Subunits, ...**5.0616**

CILIA DIFFERENTIATION IN MARINE EMBRYOS ...Cilia and Flagella, Lugworms, Marine Segmentedworm, Sea Urchins & Other Echinoderm, ...**5.0617**

ULTRASTRUCTURE OF EARLY CLEAVAGE STAGES IN THE EGG OF LYMNAEA SP ...Cell Cycle, Electron Microscopy, Gastropods -slugs,conch,snails, Invertebrate Anatomy, Microtubules, ...**5.0509**

PROTEIN SYNTHESIS DURING THE EARLY DEVELOPMENT OF THE SEA URCHIN EMBRYO ...Cell Injury and Autolysis, Proteins, Radiation Effects-non-specific, Ribosomes, Sea Urchins & Other Echinoderm, ...**5.0537**

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...Behavior, Clams, Maturity & Growth Stages, Oysters, Ph, Acidity -water, ...**5.0373**

ANTIGEN DISTRIBUTION OF DEVELOPING SEA URCHIN EMBRYOS ...Antigen, Immunity, Interspecific Genetic Relat. , RNA , Sea Urchins & Other Echinoderm, ...**5.0585**

LARVAL DEVELOPMENT OF DECAPOD CRUSTACEA ...Animal Taxonomy, Bibliography, Crabs, Decapoda - Non-specific, Lobsters, ...**5.0410**

DEVELOPMENTAL STUDIES OF SELECTED INVERTEBRATES ...Developmental Physiology, Hatchability, Maturity & Growth Stages, Size, ...**5.0958**

STRUCTURAL ANALYSIS OF CELL DIVISION ...Cell Cycle, Histochemistry - Cytochem, Nucleolus, Nucleus (non-specific & Ot.), Sea Urchins & Other Echinoderm, ...**5.0645**

CELL TRANSFORMATIONS, DIVISION, AND MOTION ...Ameboid Movement, Cell Cycle, Microtubules, Nucleic Acids, ...**5.0234**

PROTEIN SYNTHESIS ACTIVATION IN SEA URCHIN EGGS ...Biosynthesis, Metabolism, Proteins, Reproductive System, Sea Urchins & Other Echinoderm, ...**5.0543**

CEPHALOPOD LENS DEVELOPMENT ...Differentiation Mechanism, Lens Proteins, Microtubules, Octopus, Squid, Cuttlefish... , Visual Organs, ...**5.0424**

AN ANALYSIS OF DEVELOPMENT IN ARTEMIA SALINA EMBRYOS ...Biosynthesis, Nucleic Acids, Proteins, Ribosomes, Shrimps - Brine Or Fairy, ...**5.0406**

Developmental Physiology

AGING IN HYDROIDS ...Aging, Cell Injury and Autolysis, Environmental Physiology, Hydra, Portuguese Man-of-war, Senescence, ...**5.0597**

CONTROLLED ENVIRONMENTAL FACTORS ON THE DEVELOPMENT OF ESTUARINE AND OCEANIC CRUSTACEA ...Aquatic Ecology, Crabs, Estuaries, Salinity, Temperature, ...**5.0476**

SYSTEMATIC STUDIES ON HERMIT CRABS AND OTHER DECAPOD CRUSTACEANS ...Animal Taxonomy, Atlantic Ocean-south, Crabs, Life History Studies, ...**5.0408**

MORPHOLOGIC REGULATORY MECHANISMS IN TERRESTRIAL AND MARINE ORGANISMS ...Amphibia -non-specific & Other, Collagen, Fish -other, Metabolism, Porifera, ...**5.0982**

STUDIES ON GAMETOGENESIS IN HYDROMEDUSAE ...Basic Embryology, Differentiation Mechanism, Hydra, Portuguese Man-of-war, Regeneration and Wound, Reproductive System, Testosterone, ...**5.1040**

RESEARCH ON THE BIO-SYSTEMATICS OF THE CIRRIPEDIA ...Barnacles, Biological Rhythms, Visual Organs, ...**5.0364**

LARVAL DEVELOPMENT OF SCYLLARIDEAN LOBSTERS ...Animal Taxonomy, Environmental Physiology, Invertebrate Nutrition, Laboratory, Lobsters, ...**5.0409**

AN EXPERIMENTAL APPROACH TO THE GENETIC CONTROL OF MORPHOGENESIS IN ECHINODERMS ...Biosynthesis, Disease & Anomalies, Sea Urchins & Other Echinoderm, ...**5.0608**

CORRELATION BETWEEN ELECTRICAL PATTERNS AND MORPHOGENETIC PATTERNS DURING REGENERATION ...Electrical Fields, Hydra, Portuguese Man-of-war, Regeneration and Wound, ...**5.0602**

GROWTH, DIFFERENTIATION AND NERVE TRANSMISSION IN THE HYDROID, CAMPANULARIA ...Basic Embryology, Growth Rate, Hydra, Portuguese Man-of-war, Nervous System, ...**5.0601**

LIFE HISTORY AND DEVELOPMENT OF POLYCHAETOUS ANNELID LARVAE ...Behavior, Life History Studies, Lugworms, Marine Segmentedworm, Reproductive System, Whole Body Culture & Rearing, ...**5.0604**

BENTHIC COMMUNITIES ...Behavioral Ecology, Benthic Fauna, Bottom Sampling Device, Fouling, Metabolism, Productivity - Food Chain, ...**5.0561**

STUDIES ON MOLTING, GROWTH, AND DEVELOPMENT IN ACORN BARNACLES AND LARVAL DECAPODS ...Barnacles, Biological Rhythms, Endocrine System, Fouling, ...**5.0296**

CONTROLLED REARING OF DUNGENESS CRAB LARVAE ...Captive Rearing, Crabs, Maturity & Growth Stages, Oregon, ...**5.0486**

THE PURCHASE AND INTRODUCTION OF CULTCH MATERIALS ...Oysters, Ponds, Spawning & Nesting Sites, Stocking of Fish & Shellfish, ...**8.0009**

INVESTIGATIONS OF THE INDUCING CAPACITY OF THE POLAR LOBE IN THE DEVELOPMENT OF THE MARINE GASTROPOD ILYANASSA OBSOLETA ...Gastropods - slugs,conch,snails, Invertebrate Physiology, ...**5.0417**

REAR AND DESCRIBE LARVAE OF BIVALVES ...Captive Rearing, Clams, Freshwater Mussels, Scallops, Invertebrate Culture, ...**5.0507**

REPRODUCTIVE BIOLOGY, DEVELOPMENT, AND SYSTEMATICS OF THE SIPUNCULIDS OF THE CARIBBEAN ...Animal Taxonomy, Caribbean Sea, Invertebrates -non-specific, Range Or Territorial Distr. , Reproductive System, ...**5.0579**

SYSTEMATICS AND MORPHOLOGY OF THE SIPUNCULID LARVAE OF THE INDIAN OCEAN ...Animal Taxonomy, Indian Ocean-general, Invertebrate Anatomy, Invertebrates -non-specific, ...**5.0765**

LIFE HISTORY OF THE SHARK COPEPOD, KROYERIA DISPAR ...Copepods, Ectoparasites, Life History Studies, Whole Body Culture & Rearing, ...**5.0393**

DIAGNOSTIC CHARACTERS & DEVELOPMENT OF EXTERNAL GENITALIA IN JUVENILE GROOVED SHRIMPS OF GENUS PENAEUS FROM WESTERN ATLANTIC ...Atlantic Ocean-general, Invertebrate Anatomy, Reproductive System, Shrimps - Common, ...**5.0405**

THE DISEASES OF INVERTEBRATE ANIMALS ...Immumology, Invertebrate Pathology, Tumors, ...**5.0536**

STATOLITH DIFFERENTIATION IN AURELIA (JELLYFISH) ...Calcium, Differentiation Mechanism, Jelly Fish, Proprioceptors, ...**5.0598**

DEVELOPMENTAL STUDIES OF SELECTED INVERTEBRATES ...Basic Embryology, Hatchability, Maturity & Growth Stages, Size, ...**5.0958**

Mammals

Developmental Physiology

BREEDING AND MATERNAL BEHAVIOR AMONG THE STELLER SEA LION ...Behavior, Parturition, Seals, Spawning & Nesting Sites, ...**5.0524**

Vertebrates

Basic Embryology

EFFECTS OF IRRADIATION, TEMPERATURE AND OTHER ENVIRONMENTAL FACTORS ON SALMONID EMBRYOS ...Radiation Effects-non-specific, Salmon & Trout - Non-specific, Water Light Quality & Quantity, Water Temperature-non-specific, X and Gamma Rays, ...**5.0336**

MECHANISMS OF CYTOKINESIS IN ANIMAL CELLS ...Cell Cycle, ...**5.1008**

BIOCHEMISTRY OF FERTILIZATION AND EARLY DEVELOPMENT ...Fertilization, Reproductive System, Sea Urchins & Other Echinoderm, Vertebrates -non-specific, ...**5.0550**

CELL CONTACT IN RELATION TO GROWTH AND MORPHOGENESIS ...Adhesion, Cellular Membranes (non-spec.), Electron Microscopy, Porifera, ...5.0996

MORPHOGENETIC MOVEMENTS IN FISH EMBRYOS ...Fish - non-specific, Morphological Action, ...5.0281

DEVELOPMENTAL ANALYSIS OF FUNDULUS ...Central Nervous System, Fats, Killifishs - Cyprinodon, Phospholipids, Transplants, ...5.0316

STUDIES ON EMBRYONIC CELLS ...Chickens, Reproductive System, Sea Squirts - Tunicates, Suspension Culture, ...5.0945

BIOCHEMICAL BASIS OF SPECIFIC CELL ASSOCIATION ...Adhesion, Chickens, Pacific Ocean-general, Porifera, ...5.0946

MOLECULAR STUDIES OF DIFFERENTIATING CELLS ...Biosynthesis, Differentiation Mechanism, ...5.0984

THE INFLUENCE OF ENVIRONMENTAL FACTORS UPON DEVELOPING MERISTIC STRUCTURES IN THE MARINE FISH, FUNDULUS MAJALIS (WALBAUM) ...Developmental Physiology, Environmental Physiology, Killifishs - Cyprinodon, Water Temperature-non-specific, ...5.0298

ECOLOGY AND TAXONOMY OF TROPICAL ATLANTIC SCOMBRID EGGS AND LARVAE ...Animal Distr. (non-specific), Animal Taxonomy, Food Supply, Life History Studies, Tuna, Mackerel, Albacore... , ...5.0772

CELL TRANSFORMATIONS, DIVISION, AND MOTION ...Ameboid Movement, Cell Cycle, Microtubules, Nucleic Acids, ...5.0234

CELLULAR DIFFERENTIATION ...Active Transport, Differentiation Mechanism, Frogs, Ionic Effect, Skin Or Special Derivatives, ...5.0618

BEHAVIOR IN EMBRYOS AS IT RELATES TO ENCEPHALIZATION ...Behavior, Bullheads, Central Nervous System, Developmental Physiology, Visual Organs, ...5.0270

Developmental Physiology

IONOCYTE FORMATION IN GILL EPITHELIUM OF FISHES ...Biosynthesis, Differentiation Mechanism, Fish, Fish -non-specific, Osmoregulation, ...5.0301

THE INFLUENCE OF ENVIRONMENTAL FACTORS UPON DEVELOPING MERISTIC STRUCTURES IN THE MARINE FISH, FUNDULUS MAJALIS (WALBAUM) ...Basic Embryology, Environmental Physiology, Killifishs - Cyprinodon, Water Temperature-non-specific, ...5.0298

BIOLOGY OF THE LARVAL SEA LAMPREY ...Control of Nuisance Species, Environmental Ecology, Great Lakes-general, Lampreys, Life History Studies, ...5.0633

DEVELOPMENTAL MORPHOLOGY OF COREGONIDS ...Aquatic Ecology, Bonneville Cisco, Cisco, Lake Herring, Great Lakes-general, Vertebrate Anatomy, ...5.0274

SYSTEMATIC STUDIES OF FISHES ...Animal Taxonomy, Fish - non-specific, Life History Studies, Vertebrate Anatomy, ...5.0059

STATOLITH DIFFERENTIATION IN AURELIA (JELLYFISH) ...Calcium, Differentiation Mechanism, Jelly Fish, Proprioceptors, ...5.0598

BEHAVIOR IN EMBRYOS AS IT RELATES TO ENCEPHALIZATION ...Basic Embryology, Behavior, Bullheads, Central Nervous System, Visual Organs, ...5.0270

Developmental Psychology

Social Behavior

WHISTLE CONTOURS IN ODONTOCETE CETACEANS ...Behavioral Ecology, Mammals, Sound Production, ...5.0538

Diabetogenic, Ns

NEUROSECRETION AND ENDOCRINE PHYSIOLOGY ...Configuration, Crustacea -non-specific, Endocrine System, Hormones, Intermedin, ...5.1023

Diagenesis

BIOGEOCHEMISTRY OF TERRESTRIAL & EXTRATERRESTRIAL ORGANIC MATTER ...Biochemical, Biogenous, Biogeochemical Process, Exobiology, Organic, Sulfur Bacteria, ...7.0074

URANIUM GEOCHEMISTRY IN (MODERN) CARBONATES USING THE FISSION TRACK METHOD ...Biogeochemical Process, Carbonates-general, Chemistry, Organism Sampling Devices, Uranium, ...7.0076

THE FORMATION OF DOLOSTONE AND CHERT IN THE UPPER MIDDLE CAMBRIAN OF THE GREAT BASIN ...Cambrian Period, Chert, Dolomite, Great Basin, Petrography, ...7.0283

EARLY DIAGENESIS OF CARBONATE SEDIMENTS IN A SUPRATIDAL EVAPORITIC SETTING ...Carbonates-general, Continental Shelf, Origin, Persian Gulf, Sedimentary History, Sedimentation, ...7.0252

MARINE GEOLOGY OF THE SUB-ANTARCTIC PACIFIC REGION ...Antarctic Ocean, Core Analysis, Distribution, Origin, Petrology, Sedimentary History, ...7.0049

CARBONATE SEDIMENTATION IN THE TONGUE OF THE OCEAN, BAHAMAS ...British West Indies, Carbonates, Paleoecology, Sea Level Variations, Sedimentation, ...7.0267

THE SEDIMENTARY AND DIAGENETIC RECORD OF ENVIRONMENTAL PARAMETERS IN RECENT BAHAMIAN TIDAL FLATS ...British West Indies, Environmental Effects-geologic, Intertidal Areas, Local Stratigraphy, Paleoclimatology, ...7.0163

STABLE ISOTOPE STUDIES ON COEXISTING MINERALS IN MARINE SEDIMENTS ...Coring and Dredging, Genetic Relationships, Mineralogy, Red Sea, Salinity, Thermal, ...1.0106

THE GEOCHEMISTRY, MINERALOGY AND ORIGIN OF PELAGIC SEDIMENTS IN AREAS OF HIGH HEAT FLOW AND FRACTURE ZONES ...Chemistry, Geochemistry, Heat Flow Measurements, Mineralogy, Origin, Sedimentation, ...7.0227

TRACE ELEMENT AND STABLE ISOTOPE STUDIES OF CORAL REEF CARBONATES ...Element Ratios, Fossil Limestone, Paleoenvironments, Reefs, Trace Element Analysis, ...7.0086

DIAGENESIS OF CARBONATE SEDIMENTS ...Carbonates-general, Core Analysis, Geochemistry-general, Pore Fluids, Trace Element Analysis, ...7.0266

DIAGENESIS IN SEDIMENTS ...Cement Origin, Cementing Material, Model Studies, Pore Fluids, Textures-structures, ...7.0192

KAOLINITE AS RELATED TO ENVIRONMENT OF DEPOSITION ...Environment, Genetic Relationships, Kaolinite, Mineral Type, ...7.0239

Dicots

Mangroves

MARINE ALGAE OF THE MANGROVE ROOT COMMUNITY ...Algae- General, Habitat Studies, Marine Plants, Puerto Rico, Roots, ...5.0723

MORPHOLOGY AND TAXONOMY OF MARINE FUNGI ...Habitat Studies, Marine Fungi (non-specific), Plant Morphology, Plant Taxonomy, Sub - Tropic, Tropic, ...5.0716

Water Milfoil, Waterweed...

EFFECT OF EURASIAN WATERMILFOIL CONTROL PROCEDURES ON WILDLIFE AND OTHER ORGANISMS IN AQUATIC ENVIRONMENTS ...Contamination - Water, Diquat, Evaluation, 2,4-d, ...5.0700

Dielectric Materials

DIELECTRIC MATERIALS ...Organometallic, Submersibles, Thermal Properties, ...8.0215

Diffraction

Electron

ELECTRON MICROSCOPE AND ELECTRON DIFFRACTION STUDIES OF GEOLOGICAL SAMPLES ...Electron Microscopy, ...7.0278

Discharge

MOVEMENT OF RADIONUCLIDES IN THE COLUMBIA RIVER ESTUARY ...Columbia River, Estuaries, Radioactivity, Salinity, Sediment Transport-other, ...6.0179

HYDROLOGIC SYSTEMS ANALYSIS OF THE GREAT LAKES ...Great Lakes-general, Inflow, Water Storage, ...4.0076

FLUSHING PATTERN OF CERTAIN TIDAL STREAMS IN DELAWARE ...Aquatic Ecology, Circulation -water, Delaware, Industrial-general, Tidal Streams, ...2.0013

Discharge

CURRENT STUDY ON THE NEUSE RIVER AND ESTUARY ...Dyes, Estuaries, North Carolina, Tracers, Water Motion, ...2.0037

GENERAL COASTAL INLET STUDIES ...Coastal Engineering-other, Coastlines-shorelines, Model Studies, Synthetic Hydrology, Tides, Water Motion, ...7.0125

TIDAL DISCHARGE RESEARCH, NEW JERSEY ...Data Acquisition, Data Reduction and Analysis, Sediments, Tides, Water Quality-general, ...2.0088

Dispersion -water

TURBULENT DIFFUSION STUDY ...Chesapeake Bay, Estuaries, Tracers-general, Turbulent Flow, Water Motion, ...2.0056

HORIZONTAL DISPERSION IN SHALLOW ESTUARIES OF IRREGULAR SHAPE ...Circulation -water, Estuaries, Gulf of Mexico, Model Studies, Water Quality-general, ...2.0064

EXPERIMENTAL AND THEORETICAL STUDY OF THE HYDRODYNAMICS OF DISPERSION IN RIVERS AND ESTUARIES ...Estuaries, Flow Characteristics -water, Model Studies, Streams, Water Motion, ...2.0057

EDDY DIFFUSION AND BACTERIAL REDUCTION IN WASTE FIELDS ...Bacterial Pollutant Sources, Diffusion, Dyes, Mixing, Pollutants - Path of , Sewers, ...6.0137

SALT WATER ENTRAINMENT FOR DILUTION IN SEWER OUTFALLS ...Conduit Flow-other, Fluid Flow-other, Fluid Mixing, Ocean, Outlet, Sewers, Two-phase-other, ...8.0329

DISPERSION IN HYDROLOGIC AND COASTAL ENVIRONMENTS ...Groundwater Movement, Ocean, Shoreline - Coastline, Stratified Flow, Turbulent Flow, ...2.0051

BIG EDDIES AND MIXING PROCESSES IN THE GREAT LAKES ...Circulation -water, Effluents-waste Water, Great Lakes-general, Mixing, Water Motion, ...2.0052

GREAT LAKES RESEARCH - SPOIL DISPOSAL EFFECTS ...Great Lakes-general, Pollution - Effects of , Sediments, Spoil Banks, Suspension, Water Properties-general, ...6.0157

STUDY OF EFFECTS OF OFFSHORE DUMPING ...Circulation-general, Engineering Studies-other, Pollution - Effects of , Pollution Sources-other, Shoreline - Coastline, ...6.0144

HYDROLOGY OF COASTAL AREA IN THE VICINITY OF RICEBORO, GEORGIA ...Aquifers, Artesian Flow, Estuaries, Georgia, Saline Water Intrusion, Water Quality-general, ...9.0007

DISPERSION PROCESSES IN ESTUARIES AND RIVERS ...Dyes, Estuaries, Streams, Synthetic Hydrology, ...2.0050

Diving

NITROGEN-OXYGEN DECOMPRESSION TABLES FOR ALTITUDE FLIGHT ...Decompression Sickness, Manned Satelite, Safety, Space Medicine, Tables, Compilations, Catalogs, ...6.0099

Pressure

HUMAN PERFORMANCE ...Divers, Diving and Scuba, Medical Studies, ...6.0097

ENVIRONMENTAL PHYSIOLOGY ...Diving and Scuba, Life-support-system, Medical Studies, Submersibles, Underwater-laboratory, ...6.0093

HUMAN PERFORMANCE IN UNUSUAL ENVIRONMENTS ...Divers, Diving and Scuba, Facilities, Medical Studies, ...12.0005

DIVING MEDICINE ...Diffusion of Gases, Divers, Diving and Scuba, Occupational Hazards, ...8.0017

Decompression Sickness

MANNED DIVING RESEARCH ...Divers, Diving and Scuba, Liquid-breathing, Medical Studies, ...6.0096

DECOMPRESSION TABLE DEVELOPMENT ...Digital Computer Applications, Divers, Diving and Scuba, Mathematical Biophysic, Medical Studies, Tables, Compilations, Catalogs, ...6.0098

NITROGEN-OXYGEN DECOMPRESSION TABLES FOR ALTITUDE FLIGHT ...Diving, Manned Satelite, Safety, Space Medicine, Tables, Compilations, Catalogs, ...6.0099

DEEP DIVING DECOMPRESSION EQUIPMENT AND TECHNIQUES ...Divers, Diving and Scuba, Medical Studies, Navigation Communication, Safety, ...8.0022

Temperature and Humidity

Cold

METABOLIC ADAPTATION TO COLD ...Female, Hypothermia, Korea, Metabolism in Disease, Regulation, ...6.0092

Diving and Scuba

SEA BED INSTALLATION ...Benthonic-bottom, Deep, Stabilization, Submersibles, Underwater-construction, ...8.0331

MAN IN THE SEA - VISUAL ACUITY RESEARCH ...Acuity, Divers, Experiments and Tests, Optical, Submersibles, ...6.0089

RESEARCH SUBMARINE BEAVER MK IV ...Control-systems, Scientific-service-support, Submersibles, Technique Development, Underwater-laboratory, ...8.0265

DEEP OCEAN TECHNOLOGY ...Continental Shelf, Survey Studies, Technique Development, ...8.0049

MANNED DIVING RESEARCH ...Decompression Sickness, Divers, Liquid-breathing, Medical Studies, ...6.0096

HUMAN PERFORMANCE ...Divers, Medical Studies, Pressure, ...6.0097

LIFE SUPPORT RESEARCH ...Divers, Medical Studies, Subsurface Environments, Technique Development, ...8.0027

DECOMPRESSION TABLE DEVELOPMENT ...Decompression Sickness, Digital Computer Applications, Divers, Mathematical Biophysic, Medical Studies, Tables, Compilations, Catalogs, ...6.0098

SHARK ATTACKS ...Behavioral Ecology, Sharks, Water Environment -other, ...6.0090

ECOLOGY OF TROPICAL DEEP WATER ALGAE ...Algae-General, Benthic Flora, Plant Succession, Temporal Distribution, Tropic, Vertical Distribution, ...5.0722

SUPPORT OF THE RESEARCH VESSEL AHOYOHA III ...California, Equipment Purchase Operation, Geology-general, Marine Biology, Ships and Cruises, ...12.0008

ENVIRONMENTAL PHYSIOLOGY ...Life-support-system, Medical Studies, Pressure, Submersibles, Underwater-laboratory, ...6.0093

HUMAN PERFORMANCE IN UNUSUAL ENVIRONMENTS ...Divers, Facilities, Medical Studies, Pressure, ...12.0005

INTRODUCTION OF MARINE GAME FISHES FROM AREAS IN THE PACIFIC ...Hawaii, Pacific Ocean-north, Stocking of Fish & Shellfish, ...5.0075

SEA SLED AND SCUBA RECONNAISSANCE OF INSHORE AND STUDIES ON EFFECT OF ARTIFICIAL SHELTERS ON STANDING CROP OF FISHES ...Coastlines-shorelines, Fish -non-specific, Geomorphology-topography, Hawaii, Management -other, ...9.0008

LIFE-HISTORY AND BIOLOGICAL WORK IN THE RESTORATION AND MANAGEMENT OD SPECIES OF IMPORTANCE TO THE FISHERIES OF THE VIRGIN ISLANDS ...Commercial Fishing, Life History Studies, Management - other, Population Dynamics, Virgin Islands, ...5.0149

EFFECTS OF LOG RAFTING ON DUNGENESS CRAB ...Contamination - Water, Crabs, Forestry, Mans Activities, Pulp, Paper , and Logging, ...5.0347

POPULATION STRUCTURE OF THE LOBSTER ...Commercial Fishing, Lobsters, Long Island Sound, Population Dynamics, Size, ...5.0688

HELIUM - HEAT TRANSFER ...Air, Heat Transfer, Helium, Submersibles, Temperature Effects, ...8.0201

INVESTIGATIONS ON THE CRUSTOSE CORALLINES OF THE NORTH ATLANTIC ...Atlantic Ocean-north, Marine Plants, Plant Taxonomy, Rhodophyta (non-specific & Ot), Sedimentology-general, ...7.0172

SHALLOW WATER OCEANOGRAPHY (SEALAB III) ...Diving-system, Environmental Effects-geologic, Instrumentation-general, Underwater-laboratory, ...1.0146

DEEP OCEAN SYSTEMS ...Diving-system, Submersibles, Underwater-construction, ...8.0339

SWIMMER HIGH DEFINITION SONAR ...Diving-system, Engineering Studies-other, Maintenance-system, Sonar, Underwater-construction, ...8.0019

DIVER-ASSISTED OCEANOGRAPHY ...Benthonic-bottom, Continental Shelf, Currents-bottom, Geomorphology-topography, Mapping, Waves-internal, ...4.0098

DIVING MEDICINE ...Diffusion of Gases, Divers, Occupational Hazards, Pressure, ...8.0017

ONE ATMOSPHERE DIVERS SUIT ...Diving-system, Life-support-system, Technique Development, ...8.0020

ADVANCES HEAT SOURCES AND THERMAL INSULATION MATERIALS FOR SWIMMER HEATING ...Diving-system, Heat Transfer, Heating, Thermal, Thermal Insulators, ...**8.0021**

DEEP DIVING DECOMPRESSION EQUIPMENT AND TECHNIQUES ...Decompression Sickness, Divers, Medical Studies, Navigation Communication, Safety, ...**8.0022**

SUBMERGED OPERATIONS COMMUNICATIONS (SUBCOM) ...Converters - Coders, Waveform, ...**8.0023**

PROPULSION FOR SWIMMER VEHICLES ...Closed-cycle, Marine Propulsion, Submersibles, ...**8.0159**

DIVER NAVIGATION DEVICE ...Bathymetry, Diving-system, Navigation, Technique Development, ...**6.0131**

TEKTITE I ...Geologic Maps, Geology-general, Mapping, Submersibles, ...**4.0054**

DEVELOPMENT OF NEW FISHING TECHNIQUES ...Commercial Fishing, Fishing Gear, Geomorphology-topography, Mark, Tag Or Capture -other, Photography, Telemetry, ...**8.0151**

SEALAB III PARTICIPATION ...Behavioral Ecology, Bioluminescence, Divers, Medical Studies, Submersibles, ...**6.0091**

RESEARCH STUDIES IN MOLECULAR PHARMACOLOGY ...Anesthetic, Bonding and Binding, Mechanism of Action, Permeability, Thermodynamics, ...**6.0100**

DNA

DNA Other

GROWTH AND DIFFERENTIATION OF PLASTIDS ...Acetabularia, Biosynthesis, Cytoplasmic Inheritance, Nucleus (non-specific & Ot.), Organelle Culture, Photosynthetically Active, ...**5.0683**

FISH GENETICS AND ECOLOGY ...Estuaries, Fish -non-specific, Life History Studies, ...**5.0309**

Dna-satellite

DEGRADATION OF MARINE SURFACES BY SALT REQUIRING BACTERIA ...Control and Regulation, Fouling, Halophilic Bacteria, Isolation From Nat. environ. , Metabolic-biochemical Genetics, ...**5.0818**

Drainage

DRAINAGE PATTERN DEVELOPMENT ON TIDAL MARSHES ...Aerial Photography, Swamps-marshes, Tides, ...**7.0291**

Drift (pesticide)

MESO WIND PATTERNS IN THE CENTRAL CALIFORNIA VALLEY ...Atmospheric Pollution-general, California, Herbicides -non-specific, Land-sea Breezes, Wind Erosion, ...**3.0056**

Drift Stations

WEATHER PROGRAM - STATION T-3 ...Arctic Ocean, Energy Exchange Processes, Heat Budget, Patterns, Physical Climatology, Weather Forecasting, ...**3.0060**

ARCTIC RESEARCH LABORATORY ...Acoustical, Alaska, Arctic Ocean, Seismic Studies, Terrain Analysis, ...**12.0003**

Drilling and Coring

FLORIDA CORAL REEF STUDIES ...Environment, Florida, Geologic History-general, Quaternary Period, Reefs, ...**7.0162**

METEOROLOGICAL SUPPORT OF DEEP-SEA DRILLING OPERATIONS ...Coring and Dredging, Meteorological Studies, Teaching and Research, Waves, Weather Forecasting, ...**12.0013**

DEVELOPMENT OF DIAMOND DRILLING TECHNIQUES, FOR PHOSPHORITE DEPOSITS, USING STANDARD TOOLS PLUS BUOYANCY TANKS ...Bottom Sampling Device, Disturbed/undisturbed, Phosphate, Soil Sampling, Technique Development, ...**8.0248**

GEOLOGICAL, GEOPHYSICAL, OCEANOGRAPHIC, AND ECOLOGICAL DATA ON WORLDWIDE BASIS, ON AREAS OF HEAVY METALS POTENTIAL ...California, Continental Shelf, Oregon, Placer, Potential of Deposit, ...**7.0005**

DEVELOPMENT, TESTING AND EVALUATION OF MODIFICATIONS REQUIRED TO ADAPT DRILLING SAMPLING SYSTEMS TO THE PLATFORM ...Bottom Sampling Device, Coring and Dredging, Equipment, Platforms, Technique Development, ...**8.0256**

DEVELOPMENT OF MARINE CHURN DRILL FOR SAMPLING UNCONSOLIDATED DEPOSITS ...Bottom Sampling Device, Soil Sampling, Technique Development, Unconsolidated Deposits, ...**8.0250**

OREGON-NORTHERN CALIFORNIA PLACER DEPOSITS ...California, Deposits-ores, Oregon, Placer, Reconnaissance, ...**7.0009**

DEVELOPMENT OF AN ELECTRONIC METHOD FOR THE AUTOMATIC SHIPBOARD RECORDING OF DRILL PERFORMANCE DATA ...Data Acquisition, Data Acquisition Systems, Non-electrical Measurements, Recording Systems, Technique Development, ...**8.0247**

Drying

Freeze

FABRIC OF MARINE MUDS ...Fabric, Physical Properties, Size, Terrigenous, Textures-structures, ...**7.0242**

Earth Electrical Properties

Earth-telluric Current

EARTH CURRENT STUDIES ...Aurora, Magnetic Studies, ...**4.0085**

GEOMAGNETIC STUDIES ...Airborne Probing, Atmospheric Divisions, Fluctuations, ...**7.0134**

SUBSURFACE RESISTIVITY ...Crust, Magnetic Surveys, Ocean Basins, Resistance, Texas, ...**7.0147**

Exploration Methods

Electric Logging

FEASIBILITY STUDY OF THE USE OF ELECTRICAL METHODS FOR DETERMINING SIZE AND SHAPE OF DEPOSITS ...Dimensions-distribution, Instrumental Services, Methodology, Ocean Mining, Technique Development, ...**7.0008**

Field Characteristics

STUDY OF OCEAN CURRENTS AT SEA FLOOR AND THEIR SPACTIAL CORRELATION ...Benthonic-bottom, Currents-bottom, Water Motion Recorders, ...**2.0003**

Conductivity

DETECTION OF DEEP-SEATED ANOMALIES IN ELECTRICAL CONDUCTIVITY UNDER THE GULF OF CALIFORNIA ...Anomalies, Continental Drift, Gulf of California, Heat Flows, Rift, ...**7.0099**

Induction

INDUCTION IN THE OCEAN ...Crust, Currents-ocean, Earth Interior, Fluctuations, Oceanic Fronts, ...**1.0137**

Resistance

SUBSURFACE RESISTIVITY ...Crust, Earth-telluric Current, Magnetic Surveys, Ocean Basins, Texas, ...**7.0147**

Earth Magnetism

(U) OCEANIC CRUSTAL AND MANTLE STRUCTURE - ITS ORIGIN AND EFFECT ON EXTERNAL FILEDS ...Anti-submarine-warfare, Crust, Earth Interior, Ocean Basins, Origin, ...**7.0145**

Anomalies

MAGNETICS ...Atlantic Ocean-north, Pacific Ocean-general, Ridges, Sea Floor Spreading, Trenches, ...**7.0135**

ACQUISITION, REDUCTION AND INTERPRETATION OF MARINE MAGNETIC DATA ...Data Acquisition, Data Reduction and Analysis, Magnetic Studies, Ridges, ...**4.0032**

A STUDY OF THE STRUCTURAL RELATIONS BETWEEN THE MID-PACIFIC OCEANIC RIDGES AND FRACTURE ZONES ...Ocean History, Polynesia, Ridges, Structural Studies, Tectogenesis, ...**7.0111**

DETECTION OF DEEP-SEATED ANOMALIES IN ELECTRICAL CONDUCTIVITY UNDER THE GULF OF CALIFORNIA ...Conductivity, Continental Drift, Gulf of California, Heat Flows, Rift, ...**7.0099**

THE MAGNETIZATION OF SUBMARINE BASALTS AND ITS EFFECT ON MARINE MAGNETIC ANOMALIES ...Extrusives, Field Reversals, Magnetic Studies, Paleomagnetism, Seamounts-guyots, ...7.0153

SEAMOUNT INVESTIGATION ...Data Analysis - General, Geothermal, Magnetic Studies, Ocean Mining, Seamounts-guyots, Sonar, ...7.0107

Applications

Ore Deposits

TESTING AND EVALUATION OF MAGNETOMETER/GRADIOMETER AND TOW VEHICLE SYSTEM ...Evaluation Other, Field Testing, Instrumental Services, Magnetic Studies, Placer, ...8.0116

Exploration Methods

Magnetic Surveys

GEOPHYSICAL INVESTIGATIONS IN THE TAIWAN-PHILIPPINE-NEW GUINEA REGION ...Basins, Gravity Surveys, Heat Flow Measurements, Seismic Refraction, Seismic Surveys, ...7.0129

SUBSURFACE RESISTIVITY ...Crust, Earth-telluric Current, Ocean Basins, Resistance, Texas, ...7.0147

Paleo Field Character

Direction

DEEP-SEA CORE MAGNETOMETER AND A CORE ORIENTATION SYSTEM ...Coring and Dredging, Magnetometers, Rock & Mineral Magnetics, ...8.0140

Field Reversals

SEARCH FOR FERROMAGNETICALLY TRAPPED MAGNETIC MONOPOLES OF COSMIC RAY ORIGIN ...Magnetic Monopole, Magnetic Studies, Paleomagnetism, Physical Properties, ...7.0114

A PALEOMAGNETIC STUDY OF TERTIARY AND PLEISTOCENE OCEANIC CORES ...Antarctic Ocean, Core Analysis, Pacific Ocean-north, Paleomagnetism, Quaternary Period, Tertiary Period, ...7.0166

MAGNETIC PROPERTIES OF ANTARCTIC MARINE SEDIMENTS AND ROCKS ...Antarctica, Core Analysis, Extinction, Rock & Mineral Magnetics, ...7.0233

STRATIGRAPHY AND PALEOECOLOGY OF FOSSIL SILICOFLAGELLATES FROM ANTARTIC DEEP-SEA CORES ...Antarctic Ocean, Core Analysis, Correlation, Fossil Zones, Paleontology, Paleotemperature, Phylum Protozoa, ...7.0169

THE MAGNETIZATION OF SUBMARINE BASALTS AND ITS EFFECT ON MARINE MAGNETIC ANOMALIES ...Anomalies, Extrusives, Magnetic Studies, Paleomagnetism, Seamounts-guyots, ...7.0153

Fluctuations

GEOMAGNETIC STUDIES ...Airborne Probing, Atmospheric Divisions, Earth-telluric Current, ...7.0134

INDUCTION IN THE OCEAN ...Crust, Currents-ocean, Earth Interior, Induction, Oceanic Fronts, ...1.0137

Patterns

SUPPORT OF RESEARCH VESSEL AT LAMONT GEOLOGICAL OBSERVATORY ...Distribution, Marine Biology, Ridges, Seismic Studies, Ships and Cruises, ...12.0037

Paleomagnetism

SEARCH FOR FERROMAGNETICALLY TRAPPED MAGNETIC MONOPOLES OF COSMIC RAY ORIGIN ...Field Reversals, Magnetic Monopole, Magnetic Studies, Physical Properties, ...7.0114

A PALEOMAGNETIC STUDY OF TERTIARY AND PLEISTOCENE OCEANIC CORES ...Antarctic Ocean, Core Analysis, Field Reversals, Pacific Ocean-north, Quaternary Period, Tertiary Period, ...7.0166

GEOPHYSICAL STUDIES FROM ELTANIN IN 1968 ...Antarctic Ocean, Gravity Surveys, Sea Floor Spreading, Seismic Reflection, Textures-structures, ...7.0133

PALEONTOLOGY OF LATE CENOZIC ANTARCTIC RADIOLARIA AND DIATOMS ...Antarctic Ocean, Antarctica, Class Algae, Correlation, Ocean Basins, Order Radiolaria, Paleontology, Rate of Deposition, ...7.0185

THE MAGNETIZATION OF SUBMARINE BASALTS AND ITS EFFECT ON MARINE MAGNETIC ANOMALIES ...Anomalies, Extrusives, Field Reversals, Magnetic Studies, Seamounts-guyots, ...7.0153

SEA-FLOOR SEDIMENTS AND ROCK STUDIES ...Atlantic Ocean-north, Biogenous, Core Analysis, Microfossils, Petrology, Ridges, Sedimentation, ...7.0040

Rock & Mineral Magnetics

DEEP-SEA CORE MAGNETOMETER AND A CORE ORIENTATION SYSTEM ...Coring and Dredging, Direction, Magnetometers, ...8.0140

MAGNETIC PROPERTIES OF ANTARCTIC MARINE SEDIMENTS AND ROCKS ...Antarctica, Core Analysis, Extinction, Field Reversals, ...7.0233

Earth Thermal Properties

Core Temperature

GEOTHERMAL STUDIES IN DEEP-SEA DRILL HOLES ...Abyssal, Bathyal, Borehole Geophysics, Earth Interior, Geothermal, Heat Flow Measurements, Heat Flows, Sediments-general, Technique Development, ...7.0122

Geothermal Gradient

ARCTIC BASIN HEAT FLOW ...Arctic, Coring and Dredging, Crust, Heat Flows, Physical Properties, ...7.0105

GEOTHERMAL MEASUREMENTS ...Geomorphology-topography, Heat Flow Measurements, Physical Analysis, Physical Properties, Temperature, ...7.0136

Heat Flows

ARCTIC BASIN HEAT FLOW ...Arctic, Coring and Dredging, Crust, Geothermal Gradient, Physical Properties, ...7.0105

DETECTION OF DEEP-SEATED ANOMALIES IN ELECTRICAL CONDUCTIVITY UNDER THE GULF OF CALIFORNIA ...Anomalies, Conductivity, Continental Drift, Gulf of California, Rift, ...7.0099

GEOTHERMAL STUDIES IN DEEP-SEA DRILL HOLES ...Abyssal, Bathyal, Borehole Geophysics, Core Temperature, Earth Interior, Geothermal, Heat Flow Measurements, Sediments-general, Technique Development, ...7.0122

Echinodermata

Brittle Stars

POLYCHAETES AND ECHINODERMS IN THE LABRADOR SEA ...Animal Taxonomy, Labrador Sea, Lugworms, Marine Segmentedworm, Reproductive System, Starfishes, ...5.0603

ECOLOGICAL STUDIES ON TROPICAL INTERTIDAL BRITTLESTARS ...Habitat Studies, Tropic, ...5.0615

Echinodermata -other

INTESTINAL ADSORPTION AND TRANSPORT OF NUTRIENTS IN ECHINODERANS ...Active Transport, Cellular Or Intracellular, Intestine, Metabolism, Sodium, ...5.0619

ENZYME STRUCTURE AND ITS RELATION TO TAXONOMY ...Animal Taxonomy, Conformational Studies, Enzymes - non-specific, Species, ...5.0654

Sea Cucumber

A SYSTEMATIC REVISION OF THE HOLOTHURIAN FAMILY PSOLIDAE - ECHINODERMATA - HOLOTHUROIDEA ...Animal Taxonomy, Classification - Taxonomy, Comparative Anatomy, Modern Organisms, Nomenclature, Classification, ...5.0572

DISTRIBUTION MAPS OF ANTARCTIC HOLOTHURIANS AND ECHINOIDS - ECHINODERMAT ...Charts, Environmental Ecology, Sea Urchins & Other Echinoderm, Vertical Distribution, ...5.0573

Sea Feathers,sea Lily...

STABLE ISOTOPE FRACTIONATION IN ECHINODERM CALCITE ...Animal Taxonomy, Biogeochemical Process, Calcite, Carbon, Living Organisms, Marine Organisms, Oxygen, Sea Urchins & Other Echinoderm, ...7.0085

Sea Urchins & Other Echinoderm

BIOSYNTHETIC PROCESSES DURING DEVELOPMENT OF SEA URCHIN EGGS ...Basic Embryology, Cell Cycle, Messenger RNA , Nucleic Acids, Proteins, ...5.0775

MOLECULAR ASPECTS OF CELLULAR DIFFERENTIATION AND DIVISION ...Basic Embryology, Biosynthesis, Cell Cycle, Differentiation Mechanism, Proteins, Replication, ...**5.0985**

BIOCHEMISTRY OF FERTILIZATION AND EARLY DEVELOPMENT ...Basic Embryology, Fertilization, Reproductive System, Vertebrates -non-specific, ...**5.0550**

MACROMOLECULAR EVENTS OF FERTILIZATION AND EARLY EMBRYONIC DEVELOPMENT ...Basic Embryology, Biosynthesis, Reproductive System, Ribosomes, ...**5.1011**

CHARACTERIZATION AND MODE OF ACTION OF PROTEIN VENOMS OF MARINE ANIMALS ...Lecithin, Mechanism of Action, Toxicology, Toxins, Venom, ...**6.0102**

PHYSIOLOGY OF FERTILIZATION AND NUCLEO-CYTOPLASMIC INTERACTIONS IN SEA URCHIN DEVELOPMENT ...Basic Embryology, Messenger RNA , Nucleus (non-specific & Ot.), Reproductive System, Selection & Breeding, ...**5.0673**

AN EXPERIMENTAL APPROACH TO THE GENETIC CONTROL OF MORPHOGENESIS IN ECHINODERMS ...Biosynthesis, Developmental Physiology, Disease & Anomalies, ...**5.0608**

FERTILIZATION MECHANISMS AND GAMETE PHYSIOLOGY IN MARINE INVERTEBRATES ...Basic Embryology, Male Gametes, Metabolism, Reproductive System, ...**5.0590**

RNA SYNTHESIS DURING SEA URCHIN DEVELOPMENT ...Basic Embryology, Differentiation Mechanism, Metabolic-biochemical Genetics, Mitochondria, Replication, ...**5.0611**

BIOCHEMISTRY OF DEVELOPMENT ...Basic Embryology, Control and Regulation, Differentiation Mechanism, Messenger RNA , Tryptophan Oxidase, ...**5.0994**

PRESENCE OF ENZYMES RELATED TO DNA SYNTHESIS IN EGGS OF ECHINODERMS ...Basic Embryology, Developmental Stages, DNA Polymerase, Enzyme Formation, Nucleoside Kinase, ...**5.1034**

STABLE ISOTOPE FRACTIONATION IN ECHINODERM CALCITE ...Animal Taxonomy, Biogeochemical Process, Calcite, Carbon, Living Organisms, Marine Organisms, Oxygen, Sea Feathers,sea Lily... , ...**7.0085**

MARINE WASTE DISPOSAL AND SEA URCHIN ECOLOGY ...California, Pollution Effects, Productivity - Food Chain, Sewage, ...**5.0551**

CILIA DIFFERENTIATION IN THE SEA URCHIN EMBRYO ...Basic Embryology, Cilia and Flagella, Differentiation Mechanism, Proteins, Subunits, ...**5.0616**

CILIA DIFFERENTIATION IN MARINE EMBRYOS ...Basic Embryology, Cilia and Flagella, Lugworms, Marine Segmented-worm, ...**5.0617**

PROTEIN SYNTHESIS DURING THE EARLY DEVELOPMENT OF THE SEA URCHIN EMBRYO ...Basic Embryology, Cell Injury and Autolysis, Proteins, Radiation Effects-non-specific, Ribosomes, ...**5.0537**

DISTRIBUTION MAPS OF ANTARCTIC HOLOTHURIANS AND ECHINOIDS - ECHINODERMAT ...Charts, Environmental Ecology, Sea Cucumber, Vertical Distribution, ...**5.0573**

ECOLOGY OF ECHINOIDS ...Behavioral Ecology, Benthonic-bottom, Vertical Distribution, Water Environment -other, ...**5.0571**

SAND DOLLAR COMMUNITIES ...Beaches, California, Habitat Studies, Productivity - Food Chain, ...**5.0533**

ANTIGEN DISTRIBUTION OF DEVELOPING SEA URCHIN EMBRYOS ...Antigen, Basic Embryology, Immunity, Inter-specific Genetic Relat. , RNA , ...**5.0585**

CELL DIVISION AND MITOTIC APPARATUS PROTEINS ...Biosynthesis, Cell Center & Mitot. apparatus, Cell Cycle, Centrioles, Proteins, ...**5.0666**

STRUCTURAL ANALYSIS OF CELL DIVISION ...Basic Embryology, Cell Cycle, Histochemistry - Cytochem, Nucleolus, Nucleus (non-specific & Ot.), ...**5.0645**

MODE OF ACTION OF MARINE TOXINS ...Animal Toxins, Antigen, Blood Globulins, Enzyme-substrate, ...**6.0103**

PROTEIN SYNTHESIS ACTIVATION IN SEA URCHIN EGGS ...Basic Embryology, Biosynthesis, Metabolism, Proteins, Reproductive System, ...**5.0543**

Starfishes

UTILIZATION OF ENVIRONMENTAL NUTRITIONAL RESOURCES BY STARFISH ...Digestive System, Environmental Physiology, Invertebrate Nutrition, Maturity & Growth Stages, Metabolism, ...**5.0591**

POPULATION STUDIES ON INTERTIDAL INVERTEBRATES ...Australia, Gastropods -slugs,conch,snails, Growth Rate, Longevity, Oregon, ...**5.1021**

PREDATOR PREY RELATIONSHIPS BETWEEN ECHINODERMS AND MOLLUSCE ...Behavior, Behavioral Ecology, Gastropods -slugs,conch,snails, Predation, ...**5.0351**

POLYCHAETES AND ECHINODERMS IN THE LABRADOR SEA ...Animal Taxonomy, Brittle Stars, Labrador Sea, Lugworms, Marine Segmentedworm, Reproductive System, ...**5.0603**

ISOLATION AND FUNCTION OF OVARIAN EXTRACTS CAPABLE OF INDUCING COCYTE SHEDDING AND OCYTE NUCLEAR MATURATION IN STARFISH ...Differentiation Mechanism, Female, Hormones, Nucleic Acids, Reproductive System, ...**5.0620**

NUTRIENT STORES IN REPRODUCTION IN SEA INVERTEBRATES ...Crabs, Decapoda -other, Invertebrate Nutrition, Reproductive System, ...**5.0949**

Ecology (animal)

BIOLOGY CONFERENCE SERIES ...Marine Biology, Meetings, Plant Ecology (non-specific), ...**11.0035**

MARINE BIOLOGY RESEARCH AT THE BERMUDA BIOLOGICAL STATION ...Bermuda, Marine Biology, Marine Biology (non-specific), Plant Ecology (non-specific), ...**12.0006**

SYSTEMATICS MORPHOLOGY AND ECOLOGY OF THE GENUS ERVILIA (MOLLUSCA: PELECYPODA) IN THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean-general, Freshwater Mussels, Scallops, Invertebrate Anatomy, ...**5.0458**

Applied Ecology

Biological Control

ENHANCEMENT OF RECREATIONAL USES OF ESTUARINE WATERS THROUGH STUDY OF POTENTIAL CONTROL METHODS FOR STINGING SEA NETTLES ...Chesapeake Bay, Estuaries, Jelly Fish, Recreation Sites, Water Quality-general, ...**5.0605**

Pollution Effects

ECOLOGICAL SURVEY OF EFFLUENT DISCHARGE AT TWO PULP MILLS IN HUMBOLDT COUNTY, CALIFORNIA ...California, Chemical Analysis (water), Effluents-waste Water, Pollution - Effects of , Pulp, Paper , and Logging, ...**5.0858**

COLUMBIA RIVER STUDIES ...Columbia River, Contamination - Water, Invertebrates, Oysters, Radioactivity-general, Reproductive System, ...**5.0518**

ECOLOGICAL EFFECTS OF ENVIRONMENTAL & LOW LEVEL POLLUTION STRESSES ON METABOLIC REQUIREMENTS FOR GROWTH OF GULF COAST FISHES ...Environmental Ecology, Gulf of Mexico, Metabolism, Pollution - Effects of , Pollution Sources-general, Stress, ...**5.0328**

OPTIMUM ECOLOGICAL DESIGNS FOR ESTUARINE SYSTEMS OF NORTH CAROLINA ...Domestic Wastes-general, Estuaries, Marine Biology (non-specific), North Carolina, Pollution - Effects of , Productivity - Food Chain, ...**5.0913**

ESTUARINE WATER QUALITY AND FISH DISTRIBUTION ...Contamination - Water, Environmental Physiology, Estuaries, Pulp, Paper , and Logging, Salmon & Trout - Non-specific, ...**5.0178**

IMPACT AND FATE OF POLLUTION IN ESTUARIAL WATERS ...Degradation, Estuaries, Massachusetts, Pesticides - non-specific, Pollutants - Path of , ...**6.0153**

WATER QUALITY - BENTHIC INVERTEBRATE RELATIONSHIPS IN ESTUARIES ...Benthic Fauna, Benthonic-bottom, Estuaries, Maine, Pollution - Effects of , ...**5.0894**

ENTERIC BACTERIA AND VIRUSES IN SEWAGE, WATER, AND SHELLFISH ...Bacterial Pollutant Sources, Coliforms (non-specific), Oysters, Sewage, Viral Pollutant Sources, ...**6.0052**

MARINE WASTE DISPOSAL AND SEA URCHIN ECOLOGY ...California, Productivity - Food Chain, Sea Urchins & Other Echinoderm, Sewage, ...**5.0551**

DEMONSTRATION OF THE LIMITATIONS AND EFFECTS OF WASTE DISPOSAL ON AN OCEAN SHELF ...Marine Plants, Ocean, Outlet, Pollution - Effects of , Sewers, ...**6.0146**

A SURVEY OF THE MARINE ENVIRONMENT FROM FORT ROSS, SONOMA COUNTY, TO POINT LOBOS, MONTEREY COUNTY ...California, Effluents-waste Water, Marine Environments-general, Pollution - Effects of , ...**9.0003**

ECOLOGY OF KRAFT PAPER MILL EFFLUENT IN SAPELO & ST. CATHERINES SOUNDS, GA ...Aquatic Ecology, Georgia, Pollution - Effects of , Pulp, Paper , and Logging, Streams, ...**5.0886**

EFFECTS OF KRAFT PULP MILL EFFLUENTS ON THE GROWTH AND PRODUCTION OF FISH ...Contamination - Water, Industrial Wastes, Pollution - Effects of , Population Dynamics, Pulp, Paper , and Logging, Salmon & Trout - Non-specific, ...**5.0311**

EFFECTS OF HEATED WATER IN A TIDAL ESTUARY ...Chesapeake Bay, Electric Power Plants, Pollution - Effects of , Thermal Pollution, Tidal Streams, Water Properties-general, ...**6.0145**

MEASUREMENT OF RADIONUCLIDES IN ESTUARINE AND MARINE ENVIRONMENTS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Estuaries, Marine Environments-general, Pollution - Effects of , Radioactivity-general, Reactor Sites & Rad Waste, ...**5.0912**

PESTICIDES ...Aquatic Or Soil-aquatic Cycles, Bioassay, Fish, Persistance of Residues, Pesticides -non-specific, ...**5.0881**

RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...Fish, Insecticides -non-specific, Lake Michigan, Lake Superior, Lake Trout, Brook Trout, Salmon -coho,chinook,sockeye.., ...**6.0154**

MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ORGANISMS ...Chlorinated Hydrocarbons, Food Chains, Animal And/or Man, Insecticides -non-specific, Productivity - Food Chain, ...**6.0155**

ESTUARINE ECOSYSTEMS ...Aquatic Ecology, Estuaries, Pesticides, Pollution - Effects of , Population Dynamics, ...**5.0883**

HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE FISHES ...Contamination - Water, Killifishs - Cyprinodon, Pathology, Pollution - Effects of , ...**5.0323**

HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE INVERTEBRATES ...Clams, Contamination - Water, Invertebrate Pathology, Pathology, Pollution - Effects of , Pollution Sources-other, ...**5.0497**

USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS ...Bioassays, Estuaries, Phytoplankton, Pollution - Effects of , Zooplankton, ...**5.0832**

PESTICIDE RESISTANT FISH IN NATURAL ECOSYSTEMS ...Animal Resistance -other, Endrin, Fish, Food Chains, Animal And/or Man, Rates, Doses, Concentrations, ...**5.0277**

MICROBIOLOGY OF ESTUARINE AND SHELLFISH POLLUTION ...Bioindicators, Clams, Estuaries, Oysters, Sanitation, Waste Water Treatment-general, ...**6.0162**

Public Health Ecology

ASPECTS OF RELATIONSHIPS BETWEEN MARINE ECOLOGY AND HUMAN HEALTH ...Environmental Ecology, Marine Biology (non-specific), Mechanism of Transmission, Toxic Substances -non-specific, ...**6.0182**

Reactor Sites & Rad Waste

MEASUREMENT OF RADIONUCLIDES IN ESTUARINE AND MARINE ENVIRONMENTS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Estuaries, Marine Environments-general, Pollution - Effects of , Pollution Effects, Radioactivity-general, ...**5.0912**

ACCUMULATION OF RADIOACTIVITY BY INVERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Contamination - Water, Cooperative-studies, Diagnostic Procedures, Radioactivity-general, ...**5.0474**

Aquatic Ecology

ECOLOGICAL STUDY OF DUXBURY BAY ...Bays, Habitat Studies, Massachusetts, Survey Studies, Tides, ...**5.0898**

MICROBIOLOGICAL ASSAYS OF SEAWATER USING RADIOISOTOPES ...Ciliates, Environmental Ecology, Environmental Physiology, Food Chains, Phytoplankton, Productivity - Food Chain, Thiamine, ...**5.0811**

CONTROLLED ENVIRONMENTAL FACTORS ON THE DEVELOPMENT OF ESTUARINE AND OCEANIC CRUSTACEA ...Crabs, Developmental Physiology, Estuaries, Salinity, Temperature, ...**5.0476**

YEAR-ROUND PROGRAM OF RESEARCH IN MARINE ECOLOGY ...Animal Taxonomy, Marine Biology (non-specific), Plant Ecology (non-specific), Plant Taxonomy, Training Grants, Fellowships, ...**5.0899**

LIVING AND FOSSIL ZOOPLANKTON, AND RELATED PROBLEMS OF PALEOLIMNOLOGY ...Biology, Ecological, Microfossils, Paleoecology, Zooplankton, ...**7.0171**

FACTORS AFFECTING HORIZONTAL DISTRIBUTION OF MESOPELAGIC FISHES ...Atlantic Ocean-north, Behavioral Ecology, Fish -non-specific, Range Or Territorial Distr. , Vertical Distribution, ...**5.0105**

MECHANISMS OF HOMING AND ORIENTATION OF SALMO CLARKI IN YELLOWSTONE LAKE AND ITS TRIBUTARIES ...Behavior, Biological Rhythms, Cutthroat Trout, Wyoming, ...**5.0279**

NEUROENDOCRINE PATHWAYS IN OSMOREGULATION IN CRUSTACEANS ...Crabs, Endocrine System, Environmental Physiology, Osmoregulation, Shrimps - Common, ...**5.0427**

SYSTEMATICS OF ANTARCTIC HYMENOSTOMATIDA (PROTOZOA) ...Animal Taxonomy, Antarctica, Ciliates, Habitat Studies, ...**5.0815**

PLANKTON ECOLOGY ...Copepods, Lake Michigan, Plankton Sampling, Ships and Cruises, Zooplankton, ...**5.0803**

INVESTIGATE THE FEASIBILITY OF INTRODUCING SOCKEYE SALMON INTO RESERVOIRS ...Captive Rearing, Oregon, Reservoirs and Impoundments, Salmon -coho,chinook,sockeye.., Stocking of Fish & Shellfish, ...**5.0141**

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...Estuaries, Mans Activities, Persistance of Residues, Pesticides -non-specific, Pollution - Effects of , Population Dynamics, Standing Crops, ...**5.0880**

LIFE HISTORY STUDY OF THE MOI, POLYDACTYLUS SEXFILIS ...Fish -other, Life History Studies, Management -other, Tags, ...**5.0257**

ESTUARINE DREDGE HOLE INVESTIGATIONS ...Coring and Dredging, Estuaries, Fish -non-specific, Habitat Studies, ...**5.0908**

SILVER SALMON STUDIES IN THE RESURRECTION BAY AREA ...Alaska, Bays, Environmental Ecology, Management - other, Salmon -coho,chinook,sockeye.., ...**5.0189**

INVENTORY OF LARVAL FISH ...Brackish Water, Fish -non-specific, Maturity & Growth Stages, ...**5.0071**

PRE-EMERGENT FRY PINK SALMON FORECAST - SOUTHEASTERN ALASKA ...Alaska, Censusing, Number Or Density, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, ...**5.0019**

LOCATING AND MAPPING THE EXISTING SEED OYSTER BEDS IN DELAWARE BAY ...Bays, Delaware Bay, Mapping, Oysters, Spawning & Nesting Sites, ...**5.0381**

COPPER RIVER SOCKEYE SALMON INVESTIGATIONS ...Alaska, Biological Rhythms, Migration, Population Dynamics, Salmon -coho,chinook,sockeye.., Stocking of Fish & Shellfish, ...**5.0025**

SOCKEYE SALMON MIGRATORY BEHAVIOR AND BIOLOGICAL STATISTICS COLLECTION, SOUTHEASTERN ALASKA ...Alaska, Behavioral Ecology, Censusing, Migration, Salmon -coho,chinook,sockeye.., ...**5.0016**

STUDY OF THE RIVER PHASE OF THE LIFE HISTORIES OF ALOSA PSEUDOHARENGUS AND AESTIVALIS ...Alewife,menhaden,shad,herring, Connecticut River, Life History Studies, Spawning & Nesting Sites, ...**5.0245**

OYSTER SEED PROPAGATION STUDY ...Bays, Commercial Fishing, Oysters, Pacific Ocean-east, Spawning & Nesting Sites, ...**8.0012**

FLUSHING PATTERN OF CERTAIN TIDAL STREAMS IN DELAWARE ...Circulation -water, Delaware, Discharge, Industrial-general, Tidal Streams, ...**2.0013**

EFFECTS OF THERMAL POLLUTION ON PRODUCTIVITY AND STABILITY OF ESTUARINE COMMUNITIES ...Environmental Ecology, Estuaries, Plant Prod. (non-specific), Pollution - Effects of , Thermal Pollution, ...**6.0152**

THE BIOLOGY OF THE INFAUNA OF A TROPICAL SOFT BOTTOM AREA ...Benthic Fauna, Estuaries, Florida, Intertidal Areas, Pollution - Effects of , ...**5.0879**

TAXONOMY AND ECOLOGY OF INSHORE MARINE MICROBIOTA ...Algae- General, Animal Taxonomy, Plant Taxonomy, Protozoa -other, Range Or Territorial Distr. , ...**5.0768**

ENVIRONMENTAL BIOLOGY OF TOMALES DAY ...Bays, Benthic Fauna, California, Mans Activities, Pollution - Effects of , ...**5.0860**

MORPHOLOGY, PHYSIOLOGY AND ECOLOGY OF MARINE LAMELLIBRANCHS ...Basic Embryology, Behavior, Freshwater Mussels, Scallops, Invertebrate Anatomy, ...5.0479

SYSTEMATICS, ZOOGEOGRAPHY, AND ECOLOGY OF ELASMOBRANCHS OF THE WESTERN ATLANTIC OCEAN ...Animal Taxonomy, Atlantic Ocean-general, Chondrichthyes -other, Nearctic, ...5.0132

ECOLOGY OF SABELLARIID REEFS IN DELAWARE BAY ...Delaware Bay, Environmental Ecology, Lugworms, Marine Segmentedworm, Productivity - Food Chain, Vertical Distribution, ...5.0871

REPOPULATION OF DECIMATED SECTIONS OF WARMWATER STREAMS BY LONGEAR SUNFISH, LEPOMIS MEGALOTIS (RAFINESQUE) ...Population Dynamics, Stocking of Fish & Shellfish, Streams, Sunfish, Rock & Roanoke Bass.., Warm Water, ...5.0097

A NON-DESTRUCTIVE METHOD FOR ESTIMATING POPULATION DENSITY AND DISTANCE TO NEAREST NEIGHBOR FOR ESTUARINE MOLLUSCS ...Estuaries, Mollusks -non-specific & Other, Number Or Density, Population Dynamics, Range Or Territorial Distr. , ...5.0439

ECOLOGY OF KRAFT PAPER MILL EFFLUENT IN SAPELO & ST. CATHERINES SOUNDS, GA ...Georgia, Pollution - Effects of , Pollution Effects, Pulp, Paper , and Logging, Streams, ...5.0886

CULTURE OF RED SWAMP CRAWFISH, PROCAMBARUS CLARKI, IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Brackish Water, Captive Rearing, Crayfish, ...5.0432

ECOLOGICAL STUDIES OF THE BLUE CRAB, CALLINECTES SAPIDUS ...Crabs, Estuaries, Life History Studies, Louisiana, ...5.0433

ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...Environmental Ecology, Estuaries, Fishing, Migration, Oregon, Population Dynamics, ...5.0216

SPRING CHINOOK SALMON ECOLOGY STUDY ...Mark, Tag Or Capture -other, Oregon, Physical-general, Productivity (agricultural), Salmon -coho,chinook,sockeye.., Streams, ...5.0218

DISTRIBUTION AND ABUNDANCE OF OYSTER DRILLS (UROSALPINX CINEREA) IN THE JAMES RIVER, VIRGINIA ...Gastropods -slugs,conch,snails, Number Or Density, Streams, Vertical Distribution, Virginia, ...5.0508

INFAUNA OF LOWER CHESAPEAKE BAY ...Chesapeake Bay, Population Dynamics, Shrimp - Amphipods, Streams, Virginia, ...5.0661

MANAGEMENT OF COLUMBIA RIVER COMMERCIAL FISHERY ...Columbia River, Commercial Fishing, Legislation, Salmon -coho,chinook,sockeye.., ...5.0165

COPEPODS PARASITIC ON NEEDLEFISHES ...Copepods, Ectoparasites, Fish -other, Nomenclature, Classification, Organic Evolution, ...5.0389

DIURNAL-NOCTURNAL ACTIVITY OF THE QUEENFISH, SERIPHUS POLITUS ...Behavioral Ecology, Biological Rhythms, Drums, Fish -other, Other, Sound Production, ...5.0230

PACIFIC COASTAL ENVIRONMENT AS RELATED TO DISTRIBUTION AND ABUNDANCE OF GAME SPECIES -- SEA SURFACE TEMPERATURE MEASUREMENTS ...California, Spectral Reflectance, Temperature, ...1.0175

HYPOTHETICAL DISTRIBUTION OF 14 SPECIES OF ATLANTIC COASTAL GAME FISHES ...Atlantic Ocean-general, Environmental Ecology, Fish -other, Water Temperature-non-specific, ...5.0123

DEVELOPMENTAL MORPHOLOGY OF COREGONIDS ...Bonneville Cisco, Cisco, Lake Herring, Developmental Physiology, Great Lakes-general, Vertebrate Anatomy, ...5.0274

ABUNDANCE AND AVAILABILITY OF PRE-RECRUIT HERRING ...Alewife,menhaden,shad,herring, Environmental Ecology, Life History Studies, Number Or Density, Vertical Distribution, ...5.0208

ESTIMATION OF JUVENILE ABUNDANCE IN ESTUARINE NURSERIES ...Alewife,menhaden,shad,herring, Estuaries, Gulf of Mexico, Maturity & Growth Stages, Number Or Density, ...5.0131

PINK SALMON INVESTIGATIONS - FRESHWATER ECOLOGY ...Environmental Ecology, Maturity & Growth Stages, Mortality Rates, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, ...5.0188

POPULATION STRUCTURE OF THE ALEWIFE AND COREGONIDS ...Alewife,menhaden,shad,herring, Cisco, Lake Herring, Environmental Ecology, Lake Michigan, Population Dynamics, ...5.0106

ENVIRONMENTAL CHANGES IN LAKE ERIE ...Environmental Changes, Environmental Ecology, Ions and Gases, Lake Erie, Nutrients, ...5.0903

PLANKTON AND BENTHOS COMMUNITIES OF THE GREAT LAKES ...Benthic Organisms (non-specif), Gastropods -slugs,conch,snails, Lake Erie, Lugworms, Marine Segmentedworm, Plankton (non-specific), ...5.0801

ASSESSMENT OF LAKE SUPERIOR LAKE TROUT ...Commercial Fishing, Lake Trout, Brook Trout, Lampreys, Life History Studies, ...5.0736

LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...Control of Nuisance Species, Lake Superior, Lampreys, Larvicides, Streams, ...5.0628

SEA LAMPREY AMMOCETE REESTABLISHMENT STUDIES ...Control of Nuisance Species, Great Lakes-general, Lampreys, Larvicides, Life History Studies, Population Dynamics, ...5.0629

RELATION OF ENVIRONMENTAL FACTORS TO THE PRODUCTIVITY OF ESTUARINE SEDENTARY FAUNA ...Environmental Ecology, Estuaries, Florida, Productivity - Food Chain, ...5.0959

RESEARCH ON THE MACROBENTHOS OF THE GREAT LAKES ...Benthic Fauna, Earthworms, Food Supply, Great Lakes-general, Water Quality-general, ...5.0626

DISTRIBUTION AND ABUNDANCE OF ZOOPLANKTON IN LAKE ERIE ...Computer Applications, Environmental Ecology, Interbiotic Relat.(non-specif), Lake Erie, Population Dynamics, ...5.0802

RELATION OF RIVER-RUN IMPOUNDMENTS TO SALMON PRODUCTION ...Engineering Structures-general, Environmental Changes, Environmental Ecology, Mans Activities, Pollution - Effects of , Salmon & Trout - Non-specific, ...5.0222

SALMON PRODUCTION IN AREAS MADE INACCESSIBLE BY DAMS ...Columbia River, Engineering Structures-general, Environmental Ecology, Salmon & Trout - Non-specific, Spawning & Nesting Sites, ...5.0224

PINK SALMON INVESTIGATIONS - FRESHWATER ECOLOGY ...Alaska, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, Streams, Water Properties-general, ...5.0185

MARINE BIOLOGICAL INVESTIGATIONS STUDIES PROJECT (FISHES) ...Alaska, Bays, Fish -non-specific, Population Dynamics, ...5.0011

ESTUARINE ECOSYSTEMS ...Estuaries, Pesticides, Pollution - Effects of , Pollution Effects, Population Dynamics, ...5.0883

CHEMICAL OCEANOGRAPHY ...Circulation-general, Convection, Technique Development, Trace Elements, ...1.0134

EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...Columbia River, Gases, Dissolved -water, Migration, Mortality Rates, Nitrogen, Salmon & Trout - Non-specific, ...5.0221

FISH TRANSPORTATION ...Management -other, Migration, Salmon & Trout - Non-specific, Streams, Tags, ...8.0013

ENVIRONMENTAL CONDITIONS AND POPULATION DYNAMICS IN SELECTED UNPOLLUTED ESTUARIAL AND COASTAL AREAS ...Contamination - Water, Habitat Studies, Marine Biology (non-specific), Pollution - Effects of , Toxic Substances -non-specific, ...5.0922

EFFECTS OF HIGH TEMPERATURE, LOW OXYGEN, AND PH EXTREMES ON THE SURVIVAL OF AQUATIC INSECTS AND CRUSTACEA IMPORTANT AS TROUT FOOD ...Food Supply, Gases, Dissolved -water, High Temp. -85f Or Above, Lake Superior, Ph, Acidity -water, ...5.0464

DEVELOPMENT OF CULTURE METHODS FOR ECOLOGICALLY IMPORTANT MARINE ZOOPLANKTON SPECIES ...Copepods, Environmental Physiology, Invertebrate Culture, Zooplankton, ...5.0834

PARASITES OF PHILIPPINE FISHES ...Animal Distr. (non-specific), Fish -non-specific, Helminths, Philippines, ...5.0251

OSMOREGULATION ...Osmoregulation, Rays, Skates, Mantas, Sawfish, Sharks, Streams, ...5.0280

ENERGY TRANSFER IN LOWER MARINE TROPHIC LEVELS ...Energy Budgets, Environmental Ecology, Productivity - Food Chain, Vertical Distribution, ...5.1020

Dispersion -other

THE PORIFERA OF FANNING ISLAND, CENTRAL PACIFIC ...Animal Taxonomy, Environmental Effects-geologic, Line Islands, Porifera, ...5.0539

HAIR SEALS ...Age, Metamorphosis, Population Dynamics, Seals, Spawning & Nesting Sites, ...5.0525

MARINE BIOLOGICAL INVESTIGATIONS - ANALYSIS OF HERRING FISHERY DATA ...Age, Alaska, Alewife,menhaden,shad,herring, Data Analysis - General, ...5.0010

Distribution

Animal Distr. (non-specific)

THE BIOLOGY OF THE LAYSAN AND BLACK-FOOTED ALBATROSSES ...Age, Albatrosses, Shearwaters... , Control of Nuisance Species, Mark, Tag Or Capture -other, Spawning & Nesting Sites, ...5.0607

ECOLOGICAL FACTORS AFFECTING REPRODUCTION OF SHELLFISH (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...Maturity & Growth Stages, New York, Oysters, Reproductive System, Spawning & Nesting Sites, ...5.0374

ECOLOGY AND DISTRIBUTION OF OYSTERS AND CLAMS ...Clams, Oysters, Ponds, Productivity - Food Chain, ...5.0446

POPULATION STUDIES ...Alewife,menhaden,shad,herring, Animal Taxonomy, Environmental Ecology, Population Dynamics, ...5.0130

SEA CLAM EXPLORATIONS ...Atlantic Ocean-north, Clams, Commercial Fishing, Population Dynamics, ...5.0456

EARLY LIFE HISTORY DECAPOD CRUSTACEANS ...Crabs, Environmental Ecology, Life History Studies, Reproductive System, Shrimps - Common, ...5.0343

FISH GUIDING ...Control Systems, Fish -non-specific, Instrumental Services, Management -other, Water Environment -other, ...8.0015

ECOLOGY AND TAXONOMY OF TROPICAL ATLANTIC SCOMBRID EGGS AND LARVAE ...Animal Taxonomy, Basic Embryology, Food Supply, Life History Studies, Tuna, Mackerel, Albacore... , ...5.0772

FIELD STUDY - CAPE COD, MASS. ...Benthonic-bottom, Buoys, Environmental Ecology, Sediments-other, Temperature, ...5.0584

PARASITES OF PHILIPPINE FISHES ...Aquatic Ecology, Fish -non-specific, Helminths, Philippines, ...5.0251

Range Or Territorial Distr.

DISTRIBUTION AND BIOLOGY OF PACIFIC ZOOPLANKTON ...Animal Taxonomy, Pacific Ocean-general, Productivity - Food Chain, Vertical Distribution, Zooplankton, ...5.0745

CHONOTRICH CILIATE PROTOZOANS ...Age, Animal Taxonomy, Ciliates, Invertebrate Anatomy, Life History Studies, ...5.0742

BIOLOGICAL ASPECTS OF MIDWATER SOUND SCATTERING ...Atlantic Ocean-north, Bioluminescence, Fish -non-specific, Scattering, Sound Production, Vertical Distribution, ...1.0054

MARINE VERTEBRATES OF THE CALIFORNIA PENINSULA ...Animal Taxonomy, California, Environmental Ecology, Temperature, ...5.0554

THE SYSTEMATICS AND ZOOGEOGRAPHY OF THE BRYOZOAN FAUNA OF THE HAWAIIAN ISLANDS ...Animal Taxonomy, Australian, Bryozoa, Collections, Hawaii, ...5.0542

ASCIDIAN SPECIES ON THE ATLANTIC CONTINENTAL SHELF ...Animal Taxonomy, Atlantic Ocean-north, Continental Shelf, Sea Squirts - Tunicates, Vertical Distribution, ...5.0609

FACTORS AFFECTING HORIZONTAL DISTRIBUTION OF MESOPELAGIC FISHES ...Aquatic Ecology, Atlantic Ocean-north, Behavioral Ecology, Fish -non-specific, Vertical Distribution, ...5.0105

BIOLOGY OF THE ANTARCTIC BRACHIOPOD FAUNA ...Animal Taxonomy, Museum, ...5.0454

ECOLOGICAL INVESTIGATIONS OF SOME COMMON MARINE FISHES OFF THE MEDITERRANEAN COAST OF ISRAEL ...Fish -non-specific, Mediterranean Sea-general, Population Dynamics, Productivity - Food Chain, ...5.0089

TAXONOMY AND DISTRIBUTION OF CLUPEOIDS AND REVISION OF THE GENUS ILISHA OF THE FAMILY CLUPEIDAE ...Alewife,menhaden,shad,herring, Animal Taxonomy, Handbooks, Indian Ocean-general, Nomenclature, Classification, ...5.0088

SEA OTTER ...Alaska, Metamorphosis, Population Dynamics, Sea Lions, Fur Seals, Stocking of Mammals, ...5.0528

INTERVIEW AND OBSERVATION ...Censusing, Commercial Fishing, Continental Shelf, Fish -non-specific, ...5.0156

TAGGING SALMON IN THE OFFSHORE WATERS OF THE NORTH PACIFIC ...Bering Sea, Gulf of Alaska, Migration, Number Or Density, Salmon & Trout - Non-specific, Tags, ...5.0180

A NON-DESTRUCTIVE METHOD FOR ESTIMATING POPULATION DENSITY AND DISTANCE TO NEAREST NEIGHBOR FOR ESTUARINE MOLLUSCS ...Aquatic Ecology, Estuaries, Mollusks -non-specific & Other, Number Or Density, Population Dynamics, ...5.0439

SYSTEMATICS AND ECOLOGY OF MARINE BIRDS ...Animal Taxonomy, Handbooks, Shorebirds-gulls,terns,skimmer, World Wide, ...5.0582

AUTOMATIC DATA PROCESSING - SEABIRD DISTRIBUTION ...Birds -non-specific, Computer Methods -general, Nomenclature, Classification, World Wide, ...4.0020

REPRODUCTIVE BIOLOGY, DEVELOPMENT, AND SYSTEMATICS OF THE SIPUNCULIDS OF THE CARIBBEAN ...Animal Taxonomy, Caribbean Sea, Developmental Physiology, Invertebrates -non-specific, Reproductive System, ...5.0579

INFLUENCE OF THE PHYSICAL ENVIRONMENT ON DISTRIBUTION OF YOUNG STAGES OF COASTAL GAME FISH ...Continental Shelf, Environmental Ecology, Fish -non-specific, Maturity & Growth Stages, Physical-general, ...5.0211

DISTRIBUTION AND ECOLOGY OF ATLANTIC TUNAS ...Atlantic Ocean-general, Environmental Ecology, Temporal Distribution, Tuna, Mackerel, Albacore... , ...5.0063

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION SUBARTIC OCEANOGRAPHY ...Currents-ocean, Depth, Pacific Ocean-north, Salinity, Salmon -coho,chinook,sockeye.., Temperature, ...1.0159

EASTERN PACIFIC SHRIMPS OF THE GENUS PENAEUS ...Animal Taxonomy, Life History Studies, Pacific Ocean-general, Shrimps - Common, Vertical Distribution, ...5.0403

ZOOPLANKTON DISTRIBUTION IN THE TROPICAL ATLANTIC ...Atlantic Ocean-general, Plankton Sampling, Temperature, Tropic, Vertical Distribution, Zooplankton, ...5.0771

Temporal Distribution

SEASONAL DISTRIBUTION AND ABUNDANCE OF DEMERSAL FISH AND INVERTEBRATES IN THE MARINE WATERS ADJACENT TO THE MOUTH OF THE COLUMBIA RIVER ...Benthic Fauna, Number Or Density, Productivity - Food Chain, Radioactivity-general, Vertical Distribution, ...5.0930

SHARK RESEARCH ...Control of Nuisance Species, Fish Repellents, Sharks, Tags, ...5.0047

ECOLOGICAL SIGNIFICANCE OF PARTICULATE MATTER IN THE SEA ...Atlantic Ocean-north, Interbiotic Relat.(non-specif), Marine Bacteria, Organic Matter Content -water, Vertical Distribution, Zooplankton, ...5.0754

ICHTHYOFAUNA OF THE FLORIDA CURRENT ...Fish -non-specific, Florida, Number Or Density, Vertical Distribution, ...5.0066

ECOLOGY OF SKELETAL PLANKTON ...Animal Taxonomy, Collections, Flagellates, Gastropods -slugs,conch,snails, Paleoenvironments, Vertical Distribution, ...5.0997

BENTHONIC BIOLOGY ...Benthic Organisms (non-specif), Environmental Ecology, Fouling, Marine Biology (non-specific), Number Or Density, ...5.0900

BIOMETRY ...Marine Biology, Navigation, Population Dynamics, Statistics-general, ...4.0019

TAGGING PROGRAM ...Lobsters, Long Island Sound, Number Or Density, Population Dynamics, Tags, ...5.0372

WINTER DISTRIBUTION OF FISHES ...Continental Shelf, Environmental Ecology, Fish -non-specific, Salinity, Temperature, Winter, ...5.0153

SPRING DISTRIBUTION OF FISHES ...Commercial Fishing, Continental Shelf, Data Acquisition, Environmental Ecology, Fish -non-specific, Spring, ...5.0154

ZOOPLANKTON STUDIES IN BIG LAGOON, CALIFORNIA ...California, Lagoons, Plankton Sampling, Vertical Distribution, Zooplankton, ...5.0739

MOVEMENTS OF SEABIRDS IN THE HUMBOLDT CURRENT ...Aves -other, Biological Rhythms, Humboldt Or Peru Current, Population Dynamics, ...5.0583

ENVIRONMENTAL EFFECTS ON ISTIOPHORID FISH DISTRIBUTION ...Environmental Ecology, Gulf of Mexico, Marlin, Billfishes, Sailfish.., Ships and Cruises, ...5.0070

SUCCESSION, SPACIAL AND TEMPORAL DISTRIBUTION, AND BIOLOGY OF BENTHIC ORGANISMS ...Benthic Fauna, Benthic Flora, ...5.0638

MARINE INVERTEBRATE EXPLORATIONS ...Commercial Fishing, Freshwater Mussels, Scallops, Pacific Ocean-general, Shrimps - Common, Vertical Distribution, ...5.0733

MARINE BIOLOGICAL INVESTIGATIONS - NEKTON OF INSIDE WATERS OF SOUTHEASTERN ALASKA ...Alaska, Plankton Sampling, Population Dynamics, Zooplankton, ...5.0521

YOUNG FISHES OF A TIDAL ZONE ...Estuaries, Fish -non-specific, Habitat Studies, Life History Studies, Size, ...5.0073

DISTRIBUTION AND ECOLOGY OF ATLANTIC TUNAS ...Atlantic Ocean-general, Environmental Ecology, Range Or Territorial Distr. , Tuna, Mackerel, Albacore... , ...5.0063

INTERRELATIONS WITHIN THE PHYSICAL ENVIRONMENT ...Commercial Fishing, Density, Environmental Ecology, Sea Level Variations, ...2.0078

INPEC BIOLOGICAL OCEANOGRAPHY - (PHYTOPLANKTON AND ZOOPLANKTON RESEARCH) ...Food Supply, Pacific Ocean-north, Phytoplankton, Primary Productivity, Zooplankton, ...5.0843

SEA SURFACE SURVEILLANCE ...Caribbean Sea, Circulation-general, Tuna, Mackerel, Albacore... , Vertical Distribution, Water Properties-general, ...2.0019

Vertical Distribution

HYDROGRAPHIC AND BIOLOGICAL SURVEY OF MONTSWEAG BAY AND VICINITY ...Bays, Maine, Number Or Density, Organism Sampling Devices, Zooplankton, ...5.0893

BIOLOGY AND CHEMISTRY OF MARINE PLANKTON POPULATIONS ...Buoys, Chlorophyll, Phytoplankton, Zooplankton, ...5.0798

A STUDY OF THE DEEP CIRCULATION AND DEEP FISH POPULATIONS IN THE PACIFIC OCEAN ...Currents-ocean, Fish -non-specific, Pacific Ocean-general, Tides, ...2.0005

RADIOELEMENT STUDIES IN THE OCEANS- PLANKTON DISTRIBUTION STUDIES ...Chemical Reactions, Foraminifera, Number Or Density, Protozoa -other, ...5.0795

SEASONAL DISTRIBUTION AND ABUNDANCE OF DEMERSAL FISH AND INVERTEBRATES IN THE MARINE WATERS ADJACENT TO THE MOUTH OF THE COLUMBIA RIVER ...Benthic Fauna, Number Or Density, Productivity - Food Chain, Radioactivity-general, Temporal Distribution, ...5.0930

MID-DEPTH BIOLUMINESCENCE ...Bioluminescence, Crustacea -non-specific, ...1.0162

SYSTEMATICS OF THE ANTARCTIC AND SUBANTARCTIC GAMMARIDEAN AMPHIPODA ...Abyssal, Animal Taxonomy, Antarctic Ocean, Bathyal, Shrimp - Amphipods, ...5.0359

DISTRIBUTION AND BIOLOGY OF PACIFIC ZOOPLANKTON ...Animal Taxonomy, Pacific Ocean-general, Productivity - Food Chain, Range Or Territorial Distr. , Zooplankton, ...5.0745

COPEPOD CRUSTACEANS PARASITIC ON FISHES ...Collections, Copepods, Ectoparasites, Fish -non-specific, Indian Ocean-general, Ships and Cruises, ...5.0368

STRUCTURE OF THE FISH FAUNA OF A FLORIDA CORAL REEF ...Ecological, Fish -non-specific, Reefs, ...5.0205

STUDIES IN THE PHYSIOLOGY AND BIOCHEMISTRY OF DEEP-SEA FISHES ...Environmental Physiology, Fish -non-specific, Metabolism, Water Pressure, ...5.0237

ECOLOGICAL SIGNIFICANCE OF PARTICULATE MATTER IN THE SEA ...Atlantic Ocean-north, Interbiotic Relat.(non-specif), Marine Bacteria, Organic Matter Content -water, Temporal Distribution, Zooplankton, ...5.0754

ECOLOGY AND SEDIMENTARY PATTERNS OF FORAMINIFERA ...Chemistry, Environmental Ecology, Environmental Effects-geologic, Foraminifera, ...5.0746

ICHTHYOFAUNA OF THE FLORIDA CURRENT ...Fish -non-specific, Florida, Number Or Density, Temporal Distribution, ...5.0066

LANGMUIR CIRCULATION AND PLANKTON ECOLOGY ...Circulation-general, Phytoplankton, Range Or Territorial Distr. , Water Movement, Currents,, Wind Or Air Movement, Zooplankton, ...5.0794

BIOLOGICAL ASPECTS OF MIDWATER SOUND SCATTERING ...Atlantic Ocean-north, Bioluminescence, Fish -non-specific, Range Or Territorial Distr. , Scattering, Sound Production, ...1.0054

REVISION OF THE CLASSIFICATION AND PHYLOGENY OF THE SUBORDER BALANOMORPHA (CIRRIPEDIA - THORACICA) ...Animal Taxonomy, Barnacles, Collections, Handbooks, Nomenclature, Classification, ...5.0704

ECOLOGY OF SKELETAL PLANKTON ...Animal Taxonomy, Collections, Flagellates, Gastropods -slugs,conch,snails, Paleoenvironments, Temporal Distribution, ...5.0997

RESEARCH IN MARINE BENTHIC ECOLOGY OFF OREGON ...Benthic Fauna, Environmental Ecology, Number Or Density, Oregon, ...5.0916

MICROSTRATIFICATION OF MARINE ZOOPLANKTON ...Environmental Physiology, Growth Rate, Thermal, Zooplankton, ...5.0753

SYSTEMATICS OF DEEP SEA TREMATODES ...Animal Taxonomy, Helminths, Organic Evolution, Trematoda -other, ...5.0646

PRODUCTIVITY OF OCEANIC POPULATIONS OF VERTICALLY MIGRATING ANIMALS ...Migration, Plankton (non-specific), Population Dynamics, Productivity (agricultural), ...5.1019

EVOLUTIONARY DIVERGENCE OF DEEP WATER MARINE ANNELIDS ...Comparative Physiology, Digestive System, Environmental Physiology, Lugworms, Marine Segmentedworm, ...5.0662

DEVELOPMENT AND EVALUATION OF A NEW TECHNIQUE FOR SAMPLING ZOOPLANKTON ...Organism Sampling Devices, Population Dynamics, Productivity - Food Chain, Technique Development, Zooplankton, ...5.0786

BIOLOGY OF THE DEEP-SEA BENTHOS ...Atlantic Ocean-general, Benthic Fauna, Number Or Density, Tropic, ...5.0902

ECOLOGY OF PLANKTONIC FORAMINIFERA AND RELATED STUDIES ...Derivatives, Flagellates, Foraminifera, Gastropods -slugs,conch,snails, Plankton Sampling, ...5.0812

OCEANIC FISHES OF THE TROPICAL ATLANTIC ...Atlantic Ocean-south, Fish -non-specific, Survey Studies, Tropic, ...5.0068

SYSTEMATICS AND DISTRIBUTION OF WORMFISHES (MICRODESMIDAE) ...Animal Taxonomy, Bone, Collections, Fish -other, Vertebrate Anatomy, ...5.0115

DEEP-WATER ZOOPLANKTON OF THE SARGASSO SEA ...Abyssal, Bermuda, Sargasso Sea, Zooplankton, ...5.0738

ASCIDIAN SPECIES ON THE ATLANTIC CONTINENTAL SHELF ...Animal Taxonomy, Atlantic Ocean-north, Continental Shelf, Range Or Territorial Distr. , Sea Squirts - Tunicates, ...5.0609

FACTORS AFFECTING HORIZONTAL DISTRIBUTION OF MESOPELAGIC FISHES ...Aquatic Ecology, Atlantic Ocean-north, Behavioral Ecology, Fish -non-specific, Range Or Territorial Distr. , ...5.0105

SYSTEMATIC AND DISTRIBUTIONAL STUDY OF DEEP-SEA ECTOPROCTA (BRYOZOA) ...Adaptation, Animal Taxonomy, Bryozoa, Ecological, ...5.0650

DEEP WATER BENTHIC POLYCHAETES ...Benthic Fauna, Biology, Lugworms, Marine Segmentedworm, Photography, ...5.0540

MICROZOOPLANKTERS IN THE MARINE FOOD CHAIN ...Organism Sampling Devices, Population Dynamics, Productivity - Food Chain, Zooplankton, ...5.0748

PARASITISM IN DEEPSEA FISHES ...Fish -non-specific, Helminths, Host Specificity, Protozoa, ...5.0243

ECOLOGICAL INVESTIGATIONS OF MCMURDO SOUND ZOOPLANKTON ...Animal Taxonomy, Antarctica, Migration, Zooplankton, ...5.0756

DISTRIBUTION OF THE MID-WATER FISHES OF THE GULF OF CALIFORNIA ...Environmental Ecology, Fish -non-specific, Gulf of California, Nets, Organism Sampling Devices, ...5.0043

STUDY OF RADIOLARIA IN SURFACE SEDIMENTS OF THE NORTHEAST PACIFIC OCEAN ...Animal Taxonomy, Biogenous, Pacific Ocean-north, Protozoa -other, ...7.0187

MODERN FORAMINIFERA OFF OREGON ...Continental Shelf, Foraminifera, Oregon, Pacific Ocean-general, ...5.0820

OPERATION OF R/V TRIDENT ...Geomorphology-topography, Phytoplankton, Sea Floor Spreading, Ships and Cruises, Sound Production, Subbottom, ...12.0045

PELAGIC SHARKS OFF SOUTHERN CALIFORNIA ...Environmental Ecology, Pacific Ocean-east, Population Dynamics, Sharks, ...5.0196

ECOLOGY OF MARINE BIVALVE MOLLUSCAN LARVAE ...Behavioral Ecology, Clams, Fouling, Population Dynamics, Productivity - Food Chain, ...5.0370

BLOOD CHEMISTRY OF FISHES ...Blood Plasma and Serum, Bone, Sharks, Vertebrate Anatomy, ...5.0239

PRESSURE EFFECTS ON MARINE ORGANISMS ...Abyssal, Environmental Physiology, Pressure, Water Pressure, ...5.0943

BIOLOGIC SOUND SCATTERING ...Acoustical, Population Dynamics, Reverberation, Scattering, Zooplankton, ...1.0060

DEEP-WATER FOULING ...Biological, Fish -non-specific, Fouling, Predation, ...8.0233

BIOGRAPHIC STUDY OF THE BENTHOS OF PUERTO RICO AND THE VIRGIN ISLANDS ...Benthic Fauna, Benthic Flora, Benthonic-bottom, Currents-ocean, Range Or Territorial Distr. , Temperature, ...5.0652

SYSTEMATICS, BIOLOGY, AND HYDROGRAPHIC RELATIONS OF SOME SPECIES OF CALANUS (CRUSTACEA, COPEPODA) ...Animal Taxonomy, Copepods, Invertebrate Anatomy, Oceanic Fronts, ...5.03[illegible]7

THE DETERMINATION OF THE AVAILABILITY OF SEA ROBINS ...Benthic Fauna, Chesapeake Bay, Fish -other, Nets, ...5.0152

A STUDY OF THE SEASONAL ABUNDANCE, DISTRIBUTION AND SPECIES COMPOSITION, WITH DEPTH, OF NEKTON FAUNA, WITH PARTICULAR EMPHASIS ON FISHES ...Fish -non-specific, Life History Studies, Number Or Density, Zooplankton, ...5.0114

SEA SURVEY INVESTIGATIONS ...California Current, Fish -non-specific, Population Dynamics, Survey Studies, ...4.0117

INVESTIGATION OF ECOLOGICAL FACTORS LIMITING PRODUCTION OF THE ALASKAN PANDALID SHRIMP ...Alaska, Commercial Fishing, Life History Studies, Nets, Shrimps - Common, ...5.0345

LAKE BORGNE-CHANDELEUR SOUND SYSTEM ...Benthic Fauna, Louisiana, Number Or Density, Plankton Sampling, River Deltas, ...5.0091

TIMBALIER - TERREBONNE BAYS SYSTEM ...Benthic Fauna, Louisiana, Number Or Density, Plankton Sampling, River Deltas, ...5.0092

BRETON SOUND - MOUTH OF MISSISSIPPI RIVER SYSTEM ...Benthic Fauna, Louisiana, Number Or Density, Plankton Sampling, River Deltas, ...5.0093

VERMILION - CALCASIEU - SABINE SYSTEM ...Benthic Fauna, Louisiana, Number Or Density, Plankton Sampling, Salinity, Tides, ...5.0094

ATCHAFALAYA RIVER - GAILOU LAKE SYSTEM ...Benthic Fauna, Lakes, Louisiana, Number Or Density, Plankton Sampling, ...5.0095

DESIGN OF SAMPLING PLAN AND PROCUREMENT OF CHARTER VESSEL ...Commercial Fishing, Continental Shelf, Fish -non-specific, Nets, Number Or Density, ...4.0014

DISTRIBUTION OF LIFE WITH DEPTH ...Continental Shelf, Motion Pictures -non-specific, North Carolina, [illegible]graphy, ...5.0885

ECOLOGY OF SABELLARIID REEFS IN DELAWARE BAY ...Aquatic Ecology, Delaware Bay, Environmental Ecology, Lugworms, Marine Segmentedworm, Productivity - Food Chain, ...5.0871

ZOOPLANKTON STUDIES IN BIG LAGOON, CALIFORNIA ...California, Lagoons, Plankton Sampling, Temporal Distribution, Zooplankton, ...5.0739

ECOLOGY OF COMMERCIAL FISH SPECIES IN NORTHERN LAKE MICHIGAN ...Commercial Fishing, Fish -non-specific, Lake Michigan, Number Or Density, Population Dynamics, ...5.0112

OREGON FISHES - THEIR CLASSIFICATIONS, DISTRIBUTIONS AND LIFE HISTORIES ...Animal Taxonomy, Fresh Water, Life History Studies, Oregon, ...5.0137

OREGON FISHES - THEIR CLASSIFICATION, DISTRIBUTION AND BIOLOGY ...Animal Taxonomy, Fish -non-specific, Fresh Water, Oregon, ...5.0138

DISTRIBUTION AND ABUNDANCE OF OYSTER DRILLS (UROSALPINX CINEREA) IN THE JAMES RIVER, VIRGINIA ...Aquatic Ecology, Gastropods -slugs,conch,snails, Number Or Density, Streams, Virginia, ...5.0508

DISTRIBUTION, AGE GROWTH, AND MORTALITY STUDIES OF SALT WATER FISHES OF IMPORTANCE TO SPORT FISHERMEN ...Age, Chesapeake Bay, Drums, Growth Rate, Mortality Rates, ...5.0155

FORAMINIFERA FROM HEDLEY HARBOR, MASSACHUSETTS ...Environmental Ecology, Foraminifera, Harbors, Massachusetts, Number Or Density, ...5.0563

STUDY OF NORTH AND EQUATORIAL ATLANTIC PLANKTONIC FORAMINIFERA ...Foraminifera, Number Or Density, Oceanic Fronts, Organism Sampling Devices, ...5.0764

DISTRIBUTION MAPS OF ANTARCTIC HOLOTHURIANS AND ECHINOIDS - ECHINODERMAT ...Charts, Environmental Ecology, Sea Cucumber, Sea Urchins & Other Echinoderm, ...5.0573

MARINE POLYCHAETE WORMS OF THE NEW ENGLAND REGION (GULF OF ST. LAWRENCE TO CHESAPEAKE BAY) ...Animal Taxonomy, Lugworms, Marine Segmentedworm, Nomenclature, Classification, Northeast, ...5.0574

SYSTEMATICS AND BIOLOGY OF EPIPELAGIC AND BATHYPELAGIC FISHES ...Animal Taxonomy, Atlantic Ocean-north, Fish -other, Indian Ocean-general, Vertebrate Anatomy, ...5.0049

HYPERIID AMPHIPODS FROM THE GULF OF GUINEA ...Animal Taxonomy, Collections, Guinea, Oceanography-general, Shrimp - Amphipods, ...5.0387

ECOLOGY OF ECHINOIDS ...Behavioral Ecology, Benthonic-bottom, Sea Urchins & Other Echinoderm, Water Environment -other, ...5.0571

PACIFIC OCEAN BIOLOGICAL SURVEY PROGRAM ...Birds -non-specific, Islands, Meteorological Studies, Pacific Ocean-general, ...5.0568

ABYSSAL OSTRACODES OF THE WORLD ...Abyssal, Core Analysis, Shrimps - Seed Or Mussel, World Wide, ...5.0386

THE CEPHALOPODS OF THE CENTRAL PACIFIC ...Number Or Density, Octopus, Squid, Cuttlefish... , ...5.0399

ABYSSAL AND BATHYAL SYNOPIIDAE OF WORLD ...Abyssal, Animal Taxonomy, Bathyal, Crustacea -non-specific, World Wide, ...5.0384

SUCCESSION, SPACIAL AND TEMPORAL DISTRIBUTION, AND BIOLOGY OF BENTHIC ORGANISMS ...Benthic Fauna, Benthic Flora, Temporal Distribution, ...5.0638

PELAGIC FISH EXPLORATIONS ...Codfishes, Hake, Commercial Fishing, Fish -other, Nets, ...5.0172

MARINE INVERTEBRATE EXPLORATIONS ...Commercial Fishing, Freshwater Mussels, Scallops, Pacific Ocean-general, Shrimps - Common, Temporal Distribution, ...5.0733

BOTTOMFISH EXPLORATIONS ...Commercial Fishing, Fish -other, Nets, Pacific Ocean-east, ...5.0168

ZOOPLANKTON OF THE GULF OF MAINE ...Atlantic Ocean-north, Plankton Sampling, Population Dynamics, Zooplankton, ...5.0789

ABUNDANCE AND AVAILABILITY OF PRE-RECRUIT HERRING ...Alewife,menhaden,shad,herring, Aquatic Ecology, Environmental Ecology, Life History Studies, Number Or Density, ...5.0208

GULF OF ALASKA DEMERSAL FISH INVESTIGATIONS ...Fish -non-specific, Gulf of Alaska, Population Dynamics, Productivity (agricultural), ...5.0009

FUR SEAL RESEARCH, PELAGIC INVESTIGATIONS ...Behavioral Ecology, Food Supply, Seals, ...5.0667

STUDIES ON OPHIDIOID FISHES ...Abyssal, Animal Taxonomy, Benthic Fauna, Fish -other, Vertebrate Anatomy, ...5.0054

MECHANISMS AFFECTING THE VERTICAL AND HORIZONTAL DISTRIBUTION OF TUNAS AND RELATED SPECIES ...Behavioral Ecology, Environmental Ecology, Mark, Tag Or Capture -other, Tuna, Mackerel, Albacore... , ...5.0087

INTERRELATIONS OF ALEWIVES AND ASSOCIATED SPECIES ...Alewife,menhaden,shad,herring, Behavioral Ecology, Competition, Lake Michigan, Predation, ...5.0111

MARINE BIOLOGICAL INVESTIGATIONS - SURFACE ZOOPLANKTON PROJECT ...Alaska, Number Or Density, Plankton Sampling, Zooplankton, ...5.0737

BOTTOMFISH EXPLORATIONS ...Bering Sea, Fish -other, Gulf of Alaska, Nets, ...5.0030

ESTUARINE STUDIES OF SOUTHEASTERN ALASKA ...Alaska, Benthic Fauna, Environmental Ecology, Estuaries, Number Or Density, ...5.0852

CONTRIBUTIONS TO THE BIOLOGY OF THE ROYAL RED SHRIMP, HYMENOPENAEUS ROBUSTUS ...Atlantic Ocean-south, Maturity & Growth Stages, Number Or Density, Shrimps - Common, ...5.0421

EASTERN PACIFIC SHRIMPS OF THE GENUS PENAEUS ...Animal Taxonomy, Life History Studies, Pacific Ocean-general, Range Or Territorial Distr. , Shrimps - Common, ...5.0403

BENTHIC PENAEID SHRIMPS (OTHER THAN PENAEUS) FROM THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean-general, Collections, Continental Shelf, Shrimps - Common, ...5.0404

SEA SURFACE SURVEILLANCE ...Caribbean Sea, Circulation-general, Temporal Distribution, Tuna, Mackerel, Albacore... , Water Properties-general, ...2.0019

ZOOPLANKTON DISTRIBUTION IN THE TROPICAL ATLANTIC ...Atlantic Ocean-general, Plankton Sampling, Range Or Territorial Distr. , Temperature, Tropic, Zooplankton, ...5.0771

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DEVELOP TECHNIQUES FOR CAPTURING JUVENILE TUNAS ...Blood Typing Studies, Nets, Population Dynamics, Tuna, Mackerel, Albacore... , ...5.0078

146 D EASTROPAC ...Marine Biology, Meteorological Studies, Pacific Ocean-east, Tropic, Tuna, Mackerel, Albacore... , ...4.0113

THE OCEANOGRAPHY OF NEW ENGLAND FISHING BANKS ...Continental Shelf, Fish -other, Number Or Density, Water Environment -other, ...5.0901

BIOGEOGRAPHY OF BENTHONIC ORGANISMS ...Benthic Organisms (non-specif), Continental Shelf, Marine Biology (non-specific), Range Or Territorial Distr. , ...5.0876

THE STRUCTURE AND FUNCTION OF CRUSTACEAN EYES ...Crustacea -non-specific, Invertebrate Anatomy, Light -other, Oceanic - Pelagic, Visual Organs, ...5.0363

ENERGY TRANSFER IN LOWER MARINE TROPHIC LEVELS ...Aquatic Ecology, Energy Budgets, Environmental Ecology, Productivity - Food Chain, ...5.1020

Environmental Ecology

MICROBIOLOGICAL ASSAYS OF SEAWATER USING RADIOISOTOPES ...Aquatic Ecology, Ciliates, Environmental Physiology, Food Chains, Phytoplankton, Productivity - Food Chain, Thiamine, ...5.0811

AN ECOLOGICAL STUDY OF SOUTH BISCAYNE BAY IN THE VICINITY OF TURKEY POINT ...Applied Ecology, Balance of Nature, Bays, Electric Power Plants, Florida, Phytoplankton, Thermal Pollution, ...5.0877

MARINE COMMUNITIES ...Benthic Organisms (non-specif), Life History Studies, Model Studies, Plankton (non-specific), ...5.0861

THE OSTRACODA OF THE BAY OF NAPLES ...Invertebrate Anatomy, Italy, Life History Studies, Nomenclature, Classification, Shrimps - Seed Or Mussel, ...5.0415

ECOLOGY AND SEDIMENTARY PATTERNS OF FORAMINIFERA ...Chemistry, Environmental Effects-geologic, Foraminifera, Vertical Distribution, ...5.0746

TAXONOMY AND ECOLOGY OF NEARSHORE MARINE OSTRACODA ...Animal Taxonomy, Biofacies, Class Ostracoda, Ecological, Paleoenvironments, Shrimps - Seed Or Mussel, ...5.0707

RESEARCH IN MARINE BENTHIC ECOLOGY OFF OREGON ...Benthic Fauna, Number Or Density, Oregon, Vertical Distribution, ...5.0916

MARINE VERTEBRATES OF THE CALIFORNIA PENINSULA ...Animal Taxonomy, California, Range Or Territorial Distr. , Temperature, ...5.0554

SUPPORT OF UNIVERSITY OF GEORGIA MARINE INSTITUTE RESEARCH VESSEL OPERATION ...Continental Shelf, Continental Slope, Distribution, Estuaries, Geomorphology-topography, Marine Biology, Pollution Sources-general, Ships and Cruises, Textures-structures, ...12.0026

AIR-SEA INTERACTION AND PLANKTON ECOLOGY ...Circulation-general, Marine Biology (non-specific), Number Or Density, Plankton (non-specific), ...4.0078

ECOLOGICAL EFFECTS OF ENVIRONMENTAL & LOW LEVEL POLLUTION STRESSES ON METABOLIC REQUIREMENTS FOR GROWTH OF GULF COAST FISHES ...Gulf of Mexico, Metabolism, Pollution - Effects of , Pollution Effects, Pollution Sources-general, Stress, ...5.0328

DISTRIBUTION OF THE MID-WATER FISHES OF THE GULF OF CALIFORNIA ...Fish -non-specific, Gulf of California, Nets, Organism Sampling Devices, Vertical Distribution, ...5.0043

ZONATION OF THE WEDDELL SEA BENTHOS ...Benthic Organisms (non-specif), Marine Biology (non-specific), Temperature, Weddell Sea, ...5.0868

PELAGIC SHARKS OFF SOUTHERN CALIFORNIA ...Pacific Ocean-east, Population Dynamics, Sharks, Vertical Distribution, ...5.0196

MARINE ECOLOGICAL STUDIES ...Habitat Studies, Intertidal Areas, Invertebrates -non-specific, Stress, ...5.0917

BEHAVIOR AND SPECIFICITY IN MARINE SYMBIOSIS ...Behavioral Ecology, Fouling, Symbiosis, ...5.0951

BENTHONIC BIOLOGY ...Benthic Organisms (non-specif), Fouling, Marine Biology (non-specific), Number Or Density, Temporal Distribution, ...5.0900

MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...Bays, Mortality Rates, Oysters, Pathology, Puget Sound, ...5.0510

INVESTIGATE THE CAUSE OF MORTALITY OF PACIFIC OYSTERS ALONG THE CALIFORNIA COAST ...California, Mortality Rates, Oysters, Pathology, Training Grants, Fellowships, ...5.0360

SEAL BIOLOGY AND HARVEST ...Alaska, Interbiotic Relat.(non-specif), Life History Studies, Reproduction Studies (general), Seals, ...5.0522

SILVER SALMON STUDIES IN THE RESURRECTION BAY AREA ...Alaska, Aquatic Ecology, Bays, Management -other, Salmon -coho,chinook,sockeye.., ...5.0189

MONITORING THE EFFECTS OF LAND USE ON SALMON PRODUCTION ...Alaska, Land Use, Pulp, Paper , and Logging, Salmon & Trout - Non-specific, Streams, ...5.0192

KODIAK KING CRAB ENVIRONMENTAL ZONE SURVEY ...Alaska, Continental Shelf, Horseshoe Or King Crabs, Reproductive System, ...5.0348

WINTER DISTRIBUTION OF FISHES ...Continental Shelf, Fish - non-specific, Salinity, Temperature, Temporal Distribution, Winter, ...5.0153

SPRING DISTRIBUTION OF FISHES ...Commercial Fishing, Continental Shelf, Data Acquisition, Fish -non-specific, Spring, Temporal Distribution, ...5.0154

WATER QUALITY AS RELATED TO SURVIVAL OF SALMON EGGS AND LARVAE ...Mortality Rates, Reproduction Studies (general), Salmon & Trout - Non-specific, Spawning & Nesting Sites, Water Quality-general, ...5.0227

EFFECTS OF THERMAL POLLUTION ON PRODUCTIVITY AND STABILITY OF ESTUARINE COMMUNITIES ...Aquatic Ecology, Estuaries, Plant Prod. (non-specific), Pollution - Effects of , Thermal Pollution, ...6.0152

CHEMICAL RESPONSES BY MARINE ORGANISMS TO STRESS ...Environmental Changes, Environmental Physiology, Protein, Salinity, Thermal, ...5.1026

BIONOMICS OF FISHES AND SHELLFISHES ...Aquaculture & Fish-farming, Bays, Economics-general, Oregon, Productivity - Food Chain, ...5.0920

ECOLOGY OF SABELLARIID REEFS IN DELAWARE BAY ...Aquatic Ecology, Delaware Bay, Lugworms, Marine Segmentedworm, Productivity - Food Chain, Vertical Distribution, ...5.0871

EVALUATION OF ESCAPEMENT OF ADULT SALMON TO OREGON COASTAL STREAMS ...Number Or Density, Oregon, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, Streams, ...5.0215

ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...Aquatic Ecology, Estuaries, Fishing, Migration, Oregon, Population Dynamics, ...5.0216

ALBACORE TUNA ...Behavioral Ecology, Life History Studies, Tags, Tuna, Mackerel, Albacore... , ...5.0143

POPULATION ESTIMATES OF JUVENILE COHO SALMON IN SIX COASTAL STREAMS ...Maturity & Growth Stages, Population Dynamics, Salmon -coho,chinook,sockeye.., Streams, ...5.0144

FORAMINIFERA FROM HEDLEY HARBOR, MASSACHUSETTS ...Foraminifera, Harbors, Massachusetts, Number Or Density, Vertical Distribution, ...5.0563

DISTRIBUTION MAPS OF ANTARCTIC HOLOTHURIANS AND ECHINOIDS - ECHINODERMAT ...Charts, Sea Cucumber, Sea Urchins & Other Echinoderm, Vertical Distribution, ...5.0573

WATER QUALITY AND NUTRIENTS, SACRAMENTO-SAN JOAQUIN RIVER SYSTEM ...Eutrophication, Fish -non-specific, Nutrients, Plankton (non-specific), Water Quality-general, ...6.0139

INFLUENCE OF THE PHYSICAL ENVIRONMENT ON DISTRIBUTION OF YOUNG STAGES OF COASTAL GAME FISH ...Continental Shelf, Fish -non-specific, Maturity & Growth Stages, Physical-general, Range Or Territorial Distr. , ...5.0211

ENVIRONMENTAL EFFECTS ON ISTIOPHORID FISH DISTRIBUTION ...Gulf of Mexico, Marlin, Billfishes, Sailfish.., Ships and Cruises, Temporal Distribution, ...5.0070

PRE-CONSTRUCTION ENVIRONMENTAL SURVEY ...Construction Land Use Effects, Construction Sites, Continental Shelf, Organism Sampling Devices, Reefs, ...5.0907

HYDROGRAPHY, SEDIMENTATION AND CHEMICAL ASPECTS OF THE REEF ENVIRONMENT ...Aquatic Soils, Currents-ocean, Fish -non-specific, Reefs, ...5.0212

ECOLOGY OF THE KELP FORESTS ...Behavioral Ecology, California, Fish -non-specific, Habitat Studies, Laminariaceae (non-specif.&ot), ...5.0194

ABUNDANCE AND MIGRATION STUDIES OF THE WHITE SEAPERCH (P. FURCATUS), PILE PERCH (R. VACCA), STRIPED SEAPERCH (E. LATERALIS) AND STARRY FLOU ...Fish -other, Migration, Number Or Density, Oregon, Righteye Flounders, ...**5.0934**

HYPOTHETICAL DISTRIBUTION OF 14 SPECIES OF ATLANTIC COASTAL GAME FISHES ...Aquatic Ecology, Atlantic Ocean-general, Fish -other, Water Temperature-non-specific, ...**5.0123**

BIOLOGY OF THE LARVAL SEA LAMPREY ...Control of Nuisance Species, Developmental Physiology, Great Lakes-general, Lampreys, Life History Studies, ...**5.0633**

NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...Behavioral Ecology, Competition, Control of Nuisance Species, Oysters, Predation, ...**5.0377**

PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE UPPER CHESAPEAKE BAY ...Chemical-general, Chesapeake Bay, Crustacea -non-specific, Mollusks -non-specific & Other, Physical-general, ...**1.0150**

ABUNDANCE AND AVAILABILITY OF PRE-RECRUIT HERRING ...Alewife,menhaden,shad,herring, Aquatic Ecology, Life History Studies, Number Or Density, Vertical Distribution, ...**5.0208**

BIOSTATISTICS OF HERRING ...Age, Alewife,menhaden,shad,herring, Atlantic Ocean-north, Growth Rate, Population Dynamics, Proprioceptors, ...**5.0099**

EFFECT OF ENVIRONMENTAL CHANGES ON BLUE CRAB ABUNDANCE ...Crabs, Life History Studies, Migration, Number Or Density, Population Dynamics, ...**5.0473**

POPULATION STUDIES ...Alewife,menhaden,shad,herring, Animal Distr. (non-specific), Animal Taxonomy, Population Dynamics, ...**5.0130**

CHUM SALMON INVESTIGATIONS ...Estuaries, Food Supply, Growth Rate, Life History Studies, Number Or Density, Salmon -coho,chinook,sockeye.., ...**5.0007**

PINK SALMON INVESTIGATIONS - FRESHWATER ECOLOGY ...Aquatic Ecology, Maturity & Growth Stages, Mortality Rates, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, ...**5.0188**

ADULT MIGRATION RATES ...Columbia River, Management -other, Migration, Pre-impoundment Sites, Salmon -coho,chinook,sockeye.., ...**5.0173**

POPULATION STRUCTURE OF THE ALEWIFE AND COREGONIDS ...Alewife,menhaden,shad,herring, Aquatic Ecology, Cisco, Lake Herring, Lake Michigan, Population Dynamics, ...**5.0106**

EARLY LIFE HISTORY OF COREGONIDS ...Cisco, Lake Herring, Life History Studies, Maturity & Growth Stages, Technique Development, Water Environment -other, ...**5.0110**

LAKE ERIE INVESTIGATIONS - LIFE HISTORY AND ABUNDANCE OF THE YELLOW PERC ...Commercial Fishing, Life History Studies, Nets, Population Dynamics, Yellow Perch, Darters, ...**5.0134**

ENVIRONMENTAL CHANGES IN LAKE ERIE ...Aquatic Ecology, Environmental Changes, Ions and Gases, Lake Erie, Nutrients, ...**5.0903**

DISTRIBUTION AND ECOLOGY OF ATLANTIC TUNAS ...Atlantic Ocean-general, Range Or Territorial Distr. , Temporal Distribution, Tuna, Mackerel, Albacore... , ...**5.0063**

RELATION OF ENVIRONMENTAL FACTORS TO THE PRODUCTIVITY OF ESTUARINE SEDENTARY FAUNA ...Aquatic Ecology, Estuaries, Florida, Productivity - Food Chain, ...**5.0959**

INTERRELATIONS WITHIN THE PHYSICAL ENVIRONMENT ...Commercial Fishing, Density, Sea Level Variations, Temporal Distribution, ...**2.0078**

MECHANISMS AFFECTING THE VERTICAL AND HORIZONTAL DISTRIBUTION OF TUNAS AND RELATED SPECIES ...Behavioral Ecology, Mark, Tag Or Capture -other, Tuna, Mackerel, Albacore... , Vertical Distribution, ...**5.0087**

DISTRIBUTION AND ABUNDANCE OF ZOOPLANKTON IN LAKE ERIE ...Aquatic Ecology, Computer Applications, Interbiotic Relat.(non-specif), Lake Erie, Population Dynamics, ...**5.0802**

ESTABLISHMENT AND PERPETUATION OF STOCKS OF EXPERIMENTAL FISH ...Behavior, Environmental Physiology, Fish -non-specific, Great Lakes-general, Life History Studies, ...**5.0109**

RELATION OF RIVER-RUN IMPOUNDMENTS TO SALMON PRODUCTION ...Aquatic Ecology, Engineering Structures-general, Environmental Changes, Mans Activities, Pollution - Effects of , Salmon & Trout - Non-specific, ...**5.0222**

SALMON PRODUCTION IN AREAS MADE INACCESSIBLE BY DAMS ...Aquatic Ecology, Columbia River, Engineering Structures-general, Salmon & Trout - Non-specific, Spawning & Nesting Sites, ...**5.0224**

LOBSTER RESEARCH ...Commercial Fishing, Habitat Studies, Lobsters, Population Dynamics, ...**5.0436**

BERING SEA KING CRAB STUDIES ...Bering Sea, Commercial Fishing, Crabs, Migration, ...**5.0341**

EARLY LIFE HISTORY DECAPOD CRUSTACEANS ...Animal Distr. (non-specific), Crabs, Life History Studies, Reproductive System, Shrimps - Common, ...**5.0343**

ESTUARINE STUDIES OF SOUTHEASTERN ALASKA ...Alaska, Benthic Fauna, Estuaries, Number Or Density, Vertical Distribution, ...**5.0852**

FISH POPULATION STUDY ...Analog Computer Applications, Fish -other, Killifishs - Cyprinodon, Population Dynamics, Tilapia, Cichlids, ...**5.0175**

PREDICTION OF ENVIRONMENT ...Biological-general, Columbia River, Low Temp. -but Above 32f, Physical-general, Reservoirs and Impoundments, Salmon & Trout - Non-specific, Snake River, Temperature, Thermal Pollution, ...**5.0225**

FISHWAY RESEARCH (BONNEVILLE LABORATORY) ...Behavioral Ecology, Engineering Structures-general, Management -other, Migration, Salmon & Trout - Non-specific, ...**8.0016**

PREDICTING COMMERCIAL SHRIMP ABUNDANCE (SHRIMP DYNAMICS PROGRAM) ...Bays, Behavioral Ecology, Commercial Fishing, Population Dynamics, Shrimps - Common, ...**5.0499**

RECONNAISSANCE ECOLOGIC SURVEY OF THE CONTINENTAL SHELF AND UPPER SLOPE (GULF OCEANOGRAPHY PROGRAM) ...Behavioral Ecology, Biology, Continental Shelf, Migration, Population Dynamics, Shrimps - Common, ...**5.0502**

BIOLOGICAL OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM) ...Food Supply, Gulf of Mexico, Productivity - Food Chain, Shrimps - Common, ...**5.0838**

DESCRIPTIVE PHYSICAL OCEANOGRAPHY OF THE EASTERN TROPICAL ATLANTIC ...Atlantic Ocean-general, Fish - non-specific, Productivity - Food Chain, Tropic, ...**4.0127**

INVESTIGATE TUNA RESOURCES OF THE TRUST TERRITORIES ...Caroline Islands, Commercial Fishing, Population Dynamics, Tuna, Mackerel, Albacore... , ...**5.0085**

SCHOOLING BEHAVIOR ...Alewife,menhaden,shad,herring, Anchovies, Behavioral Ecology, Tuna, Mackerel, Albacore... , ...**5.0038**

INVESTIGATE POPULATION DYNAMICS OF SKIPJACK TUNA IN HAWAIIAN WATERS ...Commercial Fishing, Economics, Hawaii, Population Dynamics, Tuna, Mackerel, Albacore... , ...**5.0083**

CALIFORNIA CURRENT SURVEYS ...California Current, Fish - non-specific, Pacific Ocean-east, Plankton (non-specific), ...**4.0114**

FIELD STUDY - CAPE COD, MASS. ...Animal Distr. (non-specific), Benthonic-bottom, Buoys, Sediments-other, Temperature, ...**5.0584**

ENERGY TRANSFER IN LOWER MARINE TROPHIC LEVELS ...Aquatic Ecology, Energy Budgets, Productivity - Food Chain, Vertical Distribution, ...**5.1020**

ASPECTS OF RELATIONSHIPS BETWEEN MARINE ECOLOGY AND HUMAN HEALTH ...Marine Biology (non-specific), Mechanism of Transmission, Public Health Ecology, Toxic Substances -non-specific, ...**6.0182**

Habitat Studies

ECOLOGICAL STUDY OF DUXBURY BAY ...Aquatic Ecology, Bays, Massachusetts, Survey Studies, Tides, ...**5.0898**

POPULATION STUDIES OF HAUSTORIIDAE AND GAMMARIDAE FROM NEW ENGLAND AND ON INFAUNAL AND EPIFAUNAL MARINE AMPHIPODS AT ENIWETOK ...Atolls, Micronesia, Population Dynamics, Shrimp - Amphipods, ...**5.0466**

ENVIRONMENTAL SIGNIFICANCE OF SABELLARIID REEFS ...Biology, Lugworms, Marine Segmentedworm, Reefs, ...**5.0592**

SYSTEMATIC STUDIES OF SPONGES OF THE JAMAICAN FORE-REEF SLOPE ...Animal Taxonomy, Invertebrate Anatomy, Jamaica, Porifera, Reefs, ...**5.0558**

BIOLOGICAL COLONIZATION OF A RECENTLY FORMED ISLAND ...Iceland, Islands, Productivity - Food Chain, Succession, Volcanoes, ...**5.0925**

SYSTEMATICS OF ANTARCTIC HYMENOSTOMATIDA (PROTOZOA) ...Animal Taxonomy, Antarctica, Aquatic Ecology, Ciliates, ...5.0815

MARINE ECOLOGICAL STUDIES ...Environmental Ecology, Intertidal Areas, Invertebrates -non-specific, Stress, ...5.0917

INTERACTIONS OF INTERTIDAL POPULATIONS ...Competition, Intertidal Areas, Population Dynamics, Predation, ...5.0864

AVIFAUNAL ECOLOGY OF LIMANTOUR ESTERO ...Birds - non-specific, California, Food Supply, Game Reserves & Preserves, ...5.0534

ECOLOGICAL STUDIES OF ROCKY SUBTIDAL AREAS ...Animal Taxonomy, Marine Plants, Plant Taxonomy, ...5.0865

SPORT FISH BEHAVIORAL STUDIES ...Basses -sea,white, White Perch, Behavioral Ecology, Porgies, Rockfish, Scoraionfish, ...5.0045

ESTUARINE DREDGE HOLE INVESTIGATIONS ...Aquatic Ecology, Coring and Dredging, Estuaries, Fish -non-specific, ...5.0908

EVALUATION OF HABITAT ALTERATION, CURRITUCK SOUND ...Fish -non-specific, North Carolina, Turbidity & Suspended Matter, Water Salinity, ...5.0914

SPORTFISH YIELD OF NATURAL REEFS ...Bays, California, Fishery Development -other, Population Dynamics, ...5.0199

DESIGN AND CONSTRUCTION OF BARGE AND CLAM DREDGE FOR SURVEY OF FLORIDA'S COMMERCIAL CLAMS ...Clams, Commercial Fishing, Florida, Other-design-and-construction, ...8.0284

LARVAL STUDY OF THE LOBSTER ...Atlantic Ocean-north, Lobsters, Long Island Sound, Mark, Tag Or Capture -other, Maturity & Growth Stages, Plankton Sampling, ...5.0371

MEASUREMENT OF BIOLOGICAL FACTORS OF VARIOUS HABITATS, AND THEIR RELATION TO THE BIOLOGY OF THE COMMERCIALLY IMPORTANT SPECIES ...Chemical Measurements -water, Physical Measurements -water, Plankton (non-specific), Population Dynamics, Productivity - Food Chain, ...5.0219

EVALUATION OF ATLANTIC COAST ESTUARIES ...Atlantic Ocean-north, Estuaries, Game Reserves & Preserves, Life History Studies, Waterfowl -non-specific, ...9.0020

ECOLOGICAL STUDIES ON TROPICAL INTERTIDAL BRITTLESTARS ...Brittle Stars, Tropic, ...5.0615

PHYSIOLOGICAL VARIATION IN SUBTIDAL AND INTERTIDAL MARINE INVERTEBRATES ...Intertidal Areas, Invertebrates -non-specific, ...5.0548

MARINE NEMATODES OF THE CAPE COD AREA ...Animal Taxonomy, Collections, Nematoda -other, Northeast, ...5.0566

OCEAN WATER INTRUSION INTO BACK BAY, VIRGINIA, & CURRITUCK SOUND, NORTH CAROLINA, ON THE WATERFOWL & FRESHWATER FISH HABITAT ...North Carolina, Virginia, Water Salinity, Waterfowl -non-specific, ...5.0897

ECOLOGICAL STUDIES OF ATLANTIC AND GULF COASTAL ESTUARIES OF IMPORTANCE TO WATERFOWL ...Agricultural Land Use Effects, Atlantic Ocean-general, Construction Land Use Effects, Estuaries, Gulf of Mexico, Waterfowl -non-specific, ...5.0896

LIFE HISTORY AND BEHAVIOR OF FISHES ON ARTIFICAL REEFS ...Behavioral Ecology, Fish -non-specific, Life History Studies, Population Dynamics, ...5.0121

FILM PROJECT (KELP FORESTS) ...California, Cinematography, Fishery Development -other, Laminariaceae (non-specif.&ot), ...5.0678

SAND DOLLAR COMMUNITIES ...Beaches, California, Productivity - Food Chain, Sea Urchins & Other Echinoderm, ...5.0533

GULF-PENINSULA KING CRAB STUDIES ...Commercial Fishing, Crabs, Gulf of Alaska, Population Dynamics, ...5.0342

YOUNG FISHES OF A TIDAL ZONE ...Estuaries, Fish -non-specific, Life History Studies, Size, Temporal Distribution, ...5.0073

LOBSTER RESEARCH ...Commercial Fishing, Environmental Ecology, Lobsters, Population Dynamics, ...5.0436

ADULT SHRIMP STUDIES ...Alaska, Bays, Biological Rhythms, Life History Studies, Shrimps - Common, ...5.0340

EVALUATION OF ENGINEERING PROJECTS AND ESTUARINE DATA (ESTUARINE PROGRAM) ...Commercial Fishing, Engineering Structures-general, Estuaries, Gulf of Mexico, Swamps-marshes, ...9.0021

ECOLOGY OF WESTERN GULF ESTUARIES (ESTUARINE PROGRAM) ...Coastal Engineering-other, Estuaries, Gulf of Mexico, Mans Activities, Pollution - Effects of , ...5.0928

Interbiotic Relationship

Behavioral Ecology

FISHERIES RESOURCES IDENTIFICATION AND ASSESSMENT ...Aerial Photography, Commercial Fishing, Fish -non-specific, Optical, Spectral Reflectance, ...4.0149

SHARK ATTACKS ...Diving and Scuba, Sharks, Water Environment -other, ...6.0090

BIOLOGICAL INSTRUMENTATION ...Biological Sciences, Instrumental Services, Instrumentation-general, Navigation Systems-other, ...8.0064

PHYSIOLOGICAL MECHANISMS UNDERLYING THE BEHAVIOR OF MARINE CRUSTACEA ...Behavior, Crabs, Shrimps - Common, ...5.0428

THE ECOLOGY, MIGRATIONS AND BEHAVIOR OF MARINE TURTLES ...Migration, Reptile Studies -other, Spawning & Nesting Sites, Turtles, Terrapins, Tortoises, ...5.0586

VISUAL CAPACITIES IN TELEOST FISHES ...Behavior, Fish - other, Vertebrate Anatomy, Vision, Visual Organs, ...5.0290

PREDATOR PREY RELATIONSHIPS BETWEEN ECHINODERMS AND MOLLUSCE ...Behavior, Gastropods - slugs,conch,snails, Predation, Starfishes, ...5.0351

EXPERIMENTAL MANIPULATION OF MECHANICAL AND PHYSIOLOGICAL RHYTHMS - A DUAL APPROACH TO THE BIOLOGICAL CLOCK PROBLEM ...Acetabularia, Biological Rhythms, Crabs, Perching Birds - Songbirds, ...5.1002

EXPERIMENTAL AND BIOMATHEMATICAL ANALYSIS OF THE PHENOMENON OF ATTACK ...Bluegills, Bream, Computer Methods -general, Environmental Physiology, Largemouth Bass, Minnows, Predation, ...5.0535

FACTORS AFFECTING HORIZONTAL DISTRIBUTION OF MESOPELAGIC FISHES ...Aquatic Ecology, Atlantic Ocean-north, Fish -non-specific, Range Or Territorial Distr. , Vertical Distribution, ...5.0105

BENTHIC COMMUNITIES ...Benthic Fauna, Bottom Sampling Device, Developmental Physiology, Fouling, Metabolism, Productivity - Food Chain, ...5.0561

BEHAVIOR AND SPECIFICITY IN MARINE SYMBIOSIS ...Environmental Ecology, Fouling, Symbiosis, ...5.0951

ACOUSTIC-VIDEO SYSTEM FOR AQUATIC BIOACOUSTICAL AND ETHOLOGICAL RESEARCH ...Acoustical, British West Indies, Marine Biology, Marine Environments-general, ...1.0049

BEHAVIORAL STUDIES OF CETACEANS ...Locomotion - animal, Mammals, Sound Production, ...5.0596

ECOLOGY OF MARINE BIVALVE MOLLUSCAN LARVAE ...Clams, Fouling, Population Dynamics, Productivity - Food Chain, Vertical Distribution, ...5.0370

BEHAVIOR AND SENSORY PHYSIOLOGY OF SHARKS ...Auditory, Fish Repellents, Sharks, Tape Recording, Audio, Visual Organs, ...5.0253

BEHAVIOR AND SONIC ACTIVITY OF FISHES ...Environmental Physiology, Fish -other, Sonar, Sound Production, ...1.0047

WHISTLE CONTOURS IN ODONTOCETE CETACEANS ...Mammals, Social Behavior, Sound Production, ...5.0538

SPORT FISH BEHAVIORAL STUDIES ...Basses -sea,white, White Perch, Habitat Studies, Porgies, Rockfish, Scoraionfish, ...5.0045

BELUGA WHALES ...Acoustical, Life History Studies, Mammals, Sound Production, Tape Recording, Audio, ...5.0527

WALRUS BIOLOGY AND POPULATION ...Censusing, Migration, Population Dynamics, Reproduction Studies (general), Seals, ...5.0523

DEVELOPMENT OF UNDER-ICE HORIZONTAL SONAR SCANNING EQUIPMENT AND TECHNIQUES FOR LOCATING FISH SCHOOLS ...Commercial Fishing, Fish -non-specific, Lakes, Nets, Sonar, ...8.0138

FOOD HABITS STUDY OF ORGANISMS OF THE CALIFORNIA CURRENT SYSTEM ...California, California Current, Food Supply, Pacific Ocean-general, ...5.0044

SOCKEYE SALMON MIGRATORY BEHAVIOR AND BIOLOGICAL STATISTICS COLLECTION, SOUTHEASTERN ALASKA ...Alaska, Censusing, Migration, Salmon - coho,chinook,sockeye.., Streams, ...5.0027

SOCKEYE SALMON MIGRATORY BEHAVIOR AND BIOLOGICAL STATISTICS COLLECTION, SOUTHEASTERN ALASKA ...Alaska, Aquatic Ecology, Censusing, Migration, Salmon -coho,chinook,sockeye.., ...**5.0016**

ALBACORE TUNA ...Environmental Ecology, Life History Studies, Tags, Tuna, Mackerel, Albacore... , ...**5.0143**

ECOLOGY OF ECHINOIDS ...Benthonic-bottom, Sea Urchins & Other Echinoderm, Vertical Distribution, Water Environment - other, ...**5.0571**

REPRODUCTIVE ISOLATING MECHANISMS IN PANAMANIAN INSHORE MARINE FISHES ...Comparative Physiology, Fish -non-specific, Panama, Reproduction Studies (general), ...**5.0244**

ECOLOGY OF PANAMANIAN REEF COMMUNITIES ...Invertebrates -non-specific, Panama, Productivity - Food Chain, Reefs, Tropic, ...**5.0866**

BIOLOGICAL FALSE TARGETS AND RELATED ACOUSTIC CHARACTERISTICS ...Animal Taxonomy, Fish -non-specific, Sound Production, ...**1.0041**

LIFE HISTORY AND BEHAVIOR OF FISHES ON ARTIFICAL REEFS ...Fish -non-specific, Habitat Studies, Life History Studies, Population Dynamics, ...**5.0121**

DIURNAL-NOCTURNAL ACTIVITY OF THE QUEENFISH, SERIPHUS POLITUS ...Aquatic Ecology, Biological Rhythms, Drums, Fish -other, Other, Sound Production, ...**5.0230**

ECOLOGY OF THE KELP FORESTS ...California, Environmental Ecology, Fish -non-specific, Habitat Studies, Laminariaceae (non-specif.&ot), ...**5.0194**

NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...Competition, Control of Nuisance Species, Environmental Ecology, Oysters, Predation, ...**5.0377**

FUR SEAL RESEARCH, PELAGIC INVESTIGATIONS ...Food Supply, Seals, Vertical Distribution, ...**5.0667**

ADULT SALMON BEHAVIOR STUDIES IN RIVERS AND AT DAMS (SONIC TRACKING) ...Engineering Structures-general, Salmon & Trout - Non-specific, Streams, Tags, Telemetry, ...**8.0111**

MECHANISMS AFFECTING THE VERTICAL AND HORIZONTAL DISTRIBUTION OF TUNAS AND RELATED SPECIES ...Environmental Ecology, Mark, Tag Or Capture - other, Tuna, Mackerel, Albacore... , Vertical Distribution, ...**5.0087**

INTERRELATIONS OF ALEWIVES AND ASSOCIATED SPECIES ...Alewife,menhaden,shad,herring, Competition, Lake Michigan, Predation, Vertical Distribution, ...**5.0111**

MARINE FISH BEHAVIOR ...Commercial Fishing, Fish -non-specific, Fishing Gear, ...**5.0176**

FISHWAY RESEARCH (BONNEVILLE LABORATORY) ...Engineering Structures-general, Environmental Ecology, Management -other, Migration, Salmon & Trout - Non-specific, ...**8.0016**

PREDICTING COMMERCIAL SHRIMP ABUNDANCE (SHRIMP DYNAMICS PROGRAM) ...Bays, Commercial Fishing, Environmental Ecology, Population Dynamics, Shrimps - Common, ...**5.0499**

RECONNAISSANCE ECOLOGIC SURVEY OF THE CONTINENTAL SHELF AND UPPER SLOPE (GULF OCEANOGRAPHY PROGRAM) ...Biology, Continental Shelf, Environmental Ecology, Migration, Population Dynamics, Shrimps - Common, ...**5.0502**

SCHOOLING BEHAVIOR ...Alewife,menhaden,shad,herring, Anchovies, Environmental Ecology, Tuna, Mackerel, Albacore... , ...**5.0038**

CTFM SONAR ...Commercial Fishing, Locomotion -animal, Sonar and Echo Sounding, Telemetry, Tuna, Mackerel, Albacore... , ...**8.0058**

SEALAB III PARTICIPATION ...Bioluminescence, Divers, Diving and Scuba, Medical Studies, Submersibles, ...**6.0091**

Competition

INTERACTIONS OF INTERTIDAL POPULATIONS ...Habitat Studies, Intertidal Areas, Population Dynamics, Predation, ...**5.0864**

TRAMMEL NET SAMPLING IN ESTUARINE AREAS ...Estuaries, Fish -non-specific, Lakes, Nets, Population Dynamics, ...**5.0096**

NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...Behavioral Ecology, Control of Nuisance Species, Environmental Ecology, Oysters, Predation, ...**5.0377**

METHODS OF CONTROL OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...Control of Nuisance Species, Gastropods -slugs,conch,snails, Oysters, Predation, ...**5.0378**

INTERRELATIONS OF SMELT WITH NATIVE SPECIES ...Food Supply, Lake Superior, Life History Studies, Number Or Density, Smelts, ...**5.0182**

INTERRELATIONS OF ALEWIVES AND ASSOCIATED SPECIES ...Alewife,menhaden,shad,herring, Behavioral Ecology, Lake Michigan, Predation, Vertical Distribution, ...**5.0111**

Interbiotic Relat.(non-specif)

ECOLOGICAL SIGNIFICANCE OF PARTICULATE MATTER IN THE SEA ...Atlantic Ocean-north, Marine Bacteria, Organic Matter Content -water, Temporal Distribution, Vertical Distribution, Zooplankton, ...**5.0754**

RELATIONSHIPS BETWEEN PHYTOPLANKTON AND ZOOPLANKTON IN THE CARIBBEAN SEA ...Caribbean Sea, Phytoplankton, Sargassum, Vertical Distribution, Zooplankton, ...**5.0779**

DIVERSITY, COMMUNITY STRUCTURE AND TROPHIC RELATIONS OF TROPICAL ZOOPLANKTON ...Bays, Productivity - Food Chain, Tropic, Zooplankton, ...**5.0785**

SEAL BIOLOGY AND HARVEST ...Alaska, Environmental Ecology, Life History Studies, Reproduction Studies (general), Seals, ...**5.0522**

STUDIES OF SOCKEYE SALMON, ONCORHYNCHUS NERKA, IN THE NUSHAGAK DISTRICT, ALASKA ...Alaska, Commercial Fishing, Lakes, Population Dynamics, Salmon - coho,chinook,sockeye.., Spawning & Nesting Sites, ...**5.0228**

STUDIES OF FISH FAMILIES ARIIDAE AND ASPREDINIDAE ...Animal Taxonomy, Fish -other, Neotropical, Tropic, ...**5.0052**

THE ROLE OF THE SENORITA, OXYJULIS CALIFORNICA, AS A CLEANING ORGANISM ...California, Ectoparasites, Fish -other, Fishery Development -other, ...**5.0193**

CHARACTERISTICS OF LAKE SUPERIOR WHITEFISH ...Commercial Fishing, Lake Superior, Life History Studies, Salmon & Trout - Non-specific, Tags, ...**5.0183**

DISTRIBUTION AND ABUNDANCE OF ZOOPLANKTON IN LAKE ERIE ...Aquatic Ecology, Computer Applications, Environmental Ecology, Lake Erie, Population Dynamics, ...**5.0802**

Predation

PREDATOR PREY RELATIONSHIPS BETWEEN ECHINODERMS AND MOLLUSCE ...Behavior, Behavioral Ecology, Gastropods -slugs,conch,snails, Starfishes, ...**5.0351**

CHEMISTRY AND BIOLOGY OF SOME COELENTERATE NEMATOCYSTS ...Animal Toxins, Cell. organ. & Organoids - ot, Coelenterata -other, Invertebrate Physiology, ...**5.0776**

SIMULATION STUDIES OF ECOLOGICAL COMMUNITIES ...Mortality Rates, Number Or Density, Population Dynamics, Productivity - Food Chain, ...**5.0862**

EXPERIMENTAL AND BIOMATHEMATICAL ANALYSIS OF THE PHENOMENON OF ATTACK ...Behavioral Ecology, Bluegills, Bream, Computer Methods -general, Environmental Physiology, Largemouth Bass, Minnows, ...**5.0535**

THE EFFECTS OF SEAL AND FISH PREDATION ON CERTAIN ANTARCTIC BENTHIC COMMUNITIES ...Antarctica, Benthic Organisms (non-specif), Biology, Fish -non-specific, Productivity - Food Chain, Seals, ...**5.1039**

INTERACTIONS OF INTERTIDAL POPULATIONS ...Competition, Habitat Studies, Intertidal Areas, Population Dynamics, ...**5.0864**

DEEP-WATER FOULING ...Biological, Fish -non-specific, Fouling, Vertical Distribution, ...**8.0233**

ESTIMATE OF STANDING CROP OF OYSTERS AND SURVEY OF OYSTER PREDATORS IN GEORGIA ...Censusing, Georgia, Oysters, ...**5.0416**

PRELIMINARY MODIFICATIONS AND CONTROL OF NATURAL GROWING AREA ENVIRONMENTS ...Captive Rearing, Clams, Growth Rate, Mineral Content -water, Oysters, ...**5.0495**

INFLUENCE OF UNLIMITED FOOD SUPPLY ON RHYTHMIC ACTIVITY OF BLUEFISH ...Biological Rhythms, Bluefish, Food Supply, ...**5.0122**

NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...Behavioral Ecology, Competition, Control of Nuisance Species, Environmental Ecology, Oysters, ...**5.0377**

METHODS OF CONTROL OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...Competition, Control of Nuisance Species, Gastropods -slugs,conch,snails, Oysters, ...5.0378

INTERRELATIONS OF ALEWIVES AND ASSOCIATED SPECIES ...Alewife,menhaden,shad,herring, Behavioral Ecology, Competition, Lake Michigan, Vertical Distribution, ...5.0111

Symbiosis

SYSTEMATICS OF MARINE SYMBIOTIC CRUSTACEA FROM INVERTEBRATES ...Animal Taxonomy, Barnacles, Copepods, Life History Studies, ...5.0516

SYMBIOSIS BETWEEN MARINE ALGAE AND INVERTEBRATES ...Gastropods -slugs,conch,snails, Photosynthetically Active, Zooxanthella, ...5.0730

BEHAVIOR AND SPECIFICITY IN MARINE SYMBIOSIS ...Behavioral Ecology, Environmental Ecology, Fouling, ...5.0951

SYNECOLOGY OF CARIBBEAN SPONGES ...Algae- General, Caribbean Sea, Copepods, Porifera, ...5.0580

SYMBIOSIS OF TROPICAL ZOANTHIDEA AND ZOOXANTHELLAE ...Anthozoa, Messenger RNA , Metabolism, Tropic, Zooxanthella, ...5.0642

SYMBIOSIS IN CONVOLUTA ...Algae- General, Eddyworms, ...5.0713

FORMATION AND UTILIZATION OF TERPENES ...Anthozoa, Biosynthesis, Enzyme-substrate, Terpenes, Zooxanthella, ...5.0957

Life History Studies

MARINE COMMUNITIES ...Benthic Organisms (non-specif), Environmental Ecology, Model Studies, Plankton (non-specific), ...5.0861

THE OSTRACODA OF THE BAY OF NAPLES ...Environmental Ecology, Invertebrate Anatomy, Italy, Nomenclature, Classification, Shrimps - Seed Or Mussel, ...5.0415

CHONOTRICH CILIATE PROTOZOANS ...Age, Animal Taxonomy, Ciliates, Invertebrate Anatomy, Range Or Territorial Distr. , ...5.0742

SYSTEMATIC STUDIES ON HERMIT CRABS AND OTHER DECAPOD CRUSTACEANS ...Animal Taxonomy, Atlantic Ocean-south, Crabs, Developmental Physiology, ...5.0408

NORTH AMERICAN POST-OLIGOCENE CYTHERID OSTRACODS ...Animal Taxonomy, Invertebrate Anatomy, Nearctic, Phylogenies, Shrimps - Seed Or Mussel, ...7.0179

SYSTEMATIC STUDIES OF CERTAIN MARINE PARASITIC WORMS ...Animal Taxonomy, Helminths, Red Worms, Eye Works... , Trematoda -other, ...5.0541

BARNACLES OF THE EASTERN PACIFIC ...Barnacles, Pacific Ocean-east, ...5.0515

SYSTEMATICS OF MARINE SYMBIOTIC CRUSTACEA FROM INVERTEBRATES ...Animal Taxonomy, Barnacles, Copepods, Symbiosis, ...5.0516

LIFE HISTORY AND DEVELOPMENT OF POLYCHAETOUS ANNELID LARVAE ...Behavior, Developmental Physiology, Lugworms, Marine Segmentedworm, Reproductive System, Whole Body Culture & Rearing, ...5.0604

LIFE HISTORY STUDY OF THE MOI, POLYDACTYLUS SEXFILIS ...Aquatic Ecology, Fish -other, Management -other, Tags, ...5.0257

BELUGA WHALES ...Acoustical, Behavioral Ecology, Mammals, Sound Production, Tape Recording, Audio, ...5.0527

SEAL BIOLOGY AND HARVEST ...Alaska, Environmental Ecology, Interbiotic Relat.(non-specif), Reproduction Studies (general), Seals, ...5.0522

CREEL CENSUS OF SUMMER FLOUNDER SPORT FISHERY IN GREAT BAY, NEW JERSEY ...Bays, Censusing, Lefteye Flounders, Legislation, New Jersey, ...5.0124

STUDY ON THE DISTRIBUTION AND ABUNDANCE OF PINK SHRIMP, PANDALUS JORDANI, IN THE PACIFIC OCEAN OFF OREGON ...Censusing, Fishing Gear, Pacific Ocean-general, Population Dynamics, Shrimps - Common, ...5.0487

A STUDY OF THE SEASONAL ABUNDANCE, DISTRIBUTION AND SPECIES COMPOSITION, WITH DEPTH, OF NEKTON FAUNA, WITH PARTICULAR EMPHASIS ON FISHES ...Fish -non-specific, Number Or Density, Vertical Distribution, Zooplankton, ...5.0114

PORT SAMPLING - CRESENT CITY, BROOKINGS, PORT ORFORD ...Crabs, Fish -non-specific, Nets, Shrimps - Common, ...5.0356

DUNGENESS CRAB POPULATION DYNAMICS STUDY ...Alaska, Crabs, Population Dynamics, Tags, ...5.0346

INVESTIGATION OF ECOLOGICAL FACTORS LIMITING PRODUCTION OF THE ALASKAN PANDALID SHRIMP ...Alaska, Commercial Fishing, Nets, Shrimps - Common, Vertical Distribution, ...5.0345

POTENTIAL FISHERY FOR RIVER HERRINGS IN CONNECTICUT RIVER ...Alewife,menhaden,shad,herring, Connecticut River, Data Acquisition, Nets, Spawning & Nesting Sites, Survey Studies, ...5.0202

ARCTIC-YUKON-KUSKOKWIM AREA ANADROMOUS FISH INVESTIGATIONS ...Alaska, Commercial Fishing, Population Dynamics, Salmon & Trout - Non-specific, Salmon -coho,chinook,sockeye.., ...5.0024

LIFE-HISTORY AND BIOLOGICAL WORK IN THE RESTORATION AND MANAGEMENT OD SPECIES OF IMPORTANCE TO THE FISHERIES OF THE VIRGIN ISLANDS ...Commercial Fishing, Diving and Scuba, Management -other, Population Dynamics, Virgin Islands, ...5.0149

STUDY OF THE RIVER PHASE OF THE LIFE HISTORIES OF ALOSA PSEUDOHARENGUS AND AESTIVALIS ...Alewife,menhaden,shad,herring, Aquatic Ecology, Connecticut River, Spawning & Nesting Sites, ...5.0245

STUDY OF LIFE HISTORY AND ECOLOGY OF SERPULIDAE IN TEXAS COASTAL WATERS ...Gulf of Mexico, Lugworms, Marine Segmentedworm, Texas, ...5.0656

EVALUATION OF ATLANTIC COAST ESTUARIES ...Atlantic Ocean-north, Estuaries, Game Reserves & Preserves, Habitat Studies, Waterfowl -non-specific, ...9.0020

SHELLFISHERIES RESEARCH ...Clams, Commercial Fishing, Crabs, Number Or Density, Oysters, ...5.0383

ECOLOGICAL STUDIES OF THE BLUE CRAB, CALLINECTES SAPIDUS ...Aquatic Ecology, Crabs, Estuaries, Louisiana, ...5.0433

OREGON FISHES - THEIR CLASSIFICATIONS, DISTRIBUTIONS AND LIFE HISTORIES ...Animal Taxonomy, Fresh Water, Oregon, Vertical Distribution, ...5.0137

EARLY LIFE OF BOREAL FOOD FISH AND SHELLFISH ...Animal Taxonomy, Fish -non-specific, Mollusks -non-specific & Other, Mortality Rates, ...5.0139

ALBACORE TUNA ...Behavioral Ecology, Environmental Ecology, Tags, Tuna, Mackerel, Albacore... , ...5.0143

MANAGEMENT OF OREGON DUNGENESS CRAB RESOURCE ...Commercial Fishing, Crabs, Legislation, Oregon, Tags, ...5.0489

FISH GENETICS AND ECOLOGY ...DNA Other, Estuaries, Fish -non-specific, ...5.0309

THE SYSTEMATICS AND DISTRIBUTION OF THE WORLDWIDE SQUID FAMILY BATHYTEUTHIDAE ...Animal Taxonomy, Number Or Density, Octopus, Squid, Cuttlefish... , World Wide, ...5.0400

LIFE HISTORY OF THE SHARK COPEPOD, KROYERIA DISPAR ...Copepods, Developmental Physiology, Ectoparasites, Whole Body Culture & Rearing, ...5.0393

LIFE HISTORY OF BILLFISHES ...California, Censusing, Marlin, Billfishes, Sailfish.., Mexico, ...5.0195

LIFE HISTORY AND BEHAVIOR OF FISHES ON ARTIFICAL REEFS ...Behavioral Ecology, Fish -non-specific, Habitat Studies, Population Dynamics, ...5.0121

LIFE HISTORY OF CLUPEA HARENGUS PALLASI ...Alewife,menhaden,shad,herring, Aquaculture & Fish-farming, Artifical Insemination, Water Salinity, Water Temperature-non-specific, ...5.0035

BIOLOGY OF THE LARVAL SEA LAMPREY ...Control of Nuisance Species, Developmental Physiology, Environmental Ecology, Great Lakes-general, Lampreys, ...5.0633

ABUNDANCE AND AVAILABILITY OF PRE-RECRUIT HERRING ...Alewife,menhaden,shad,herring, Aquatic Ecology, Environmental Ecology, Number Or Density, Vertical Distribution, ...5.0208

EFFECT OF ENVIRONMENTAL CHANGES ON BLUE CRAB ABUNDANCE ...Crabs, Environmental Ecology, Migration, Number Or Density, Population Dynamics, ...5.0473

BRISTOL BAY ESTUARINE ECOLOGY ...Alaska, Estuaries, Fishing Gear, Migration, Oceanic Fronts, Salmon -coho,chinook,sockeye.., ...5.0004

KARLUK LAKE RESEARCH STATION ...Mortality Rates, Population Dynamics, Productivity (agricultural), Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, ...5.0006

CHUM SALMON INVESTIGATIONS ...Environmental Ecology, Estuaries, Food Supply, Growth Rate, Number Or Density, Salmon -coho,chinook,sockeye.., ...5.0007

PINK SALMON INVESTIGATIONS - INTERTIDAL ECOLOGY ...Alaska, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, Tidal Streams, Water Salinity, ...5.0186

FUR SEAL RESEARCH, POPULATION DYNAMICS ...Age, Growth Rate, Mark, Tag Or Capture -other, Population Dynamics, Seals, ...5.0671

EARLY LIFE HISTORY OF COREGONIDS ...Cisco, Lake Herring, Environmental Ecology, Maturity & Growth Stages, Technique Development, Water Environment -other, ...5.0110

LAKE ERIE INVESTIGATIONS - LIFE HISTORY AND ABUNDANCE OF THE YELLOW PERC ...Commercial Fishing, Environmental Ecology, Nets, Population Dynamics, Yellow Perch, Darters, ...5.0134

INTERRELATIONS OF SMELT WITH NATIVE SPECIES ...Competition, Food Supply, Lake Superior, Number Or Density, Smelts, ...5.0182

CHARACTERISTICS OF LAKE SUPERIOR WHITEFISH ...Commercial Fishing, Interbiotic Relat.(non-specif), Lake Superior, Salmon & Trout - Non-specific, Tags, ...5.0183

ASSESSMENT OF LAKE SUPERIOR LAKE TROUT ...Aquatic Ecology, Commercial Fishing, Lake Trout, Brook Trout, Lampreys, ...5.0736

SEA LAMPREY AMMOCETE REESTABLISHMENT STUDIES ...Aquatic Ecology, Control of Nuisance Species, Great Lakes-general, Lampreys, Larvicides, Population Dynamics, ...5.0629

YOUNG FISHES OF A TIDAL ZONE ...Estuaries, Fish -non-specific, Habitat Studies, Size, Temporal Distribution, ...5.0073

SYSTEMATIC STUDIES OF FISHES ...Animal Taxonomy, Developmental Physiology, Fish -non-specific, Vertebrate Anatomy, ...5.0059

IDENTIFICATION AND DESCRIPTION OF FISH LARVAE ...Animal Taxonomy, Atlantic Ocean-north, Fish -non-specific, Southern, ...5.0074

LIFE HISTORY OF THE BURBOT AND LONGNOSE SUCKER ...Codfishes, Hake, Lake Superior, Lakes, Suckers, ...5.0184

ESTABLISHMENT AND PERPETUATION OF STOCKS OF EXPERIMENTAL FISH ...Behavior, Environmental Ecology, Environmental Physiology, Fish -non-specific, Great Lakes-general, ...5.0109

ADULT SHRIMP STUDIES ...Alaska, Bays, Biological Rhythms, Habitat Studies, Shrimps - Common, ...5.0340

EARLY LIFE HISTORY DECAPOD CRUSTACEANS ...Animal Distr. (non-specific), Crabs, Environmental Ecology, Reproductive System, Shrimps - Common, ...5.0343

PINK SALMON INVESTIGATIONS - EARLY SEA LIFE OF SALMON ...Alaska, Environmental Physiology, Parasitology - other, Water Temperature-non-specific, ...5.0187

GULF OF ALASKA SOCKEYE SALMON SCALES, PROTOCOL AREA SOCKEYE SALMON SCALES, AND GULF OF ALASKA PINK SALMON SCALES ..Animal Taxonomy, Gulf of Alaska, Salmon -coho,chinook,sockeye.., Scales, ...5.0334

EASTERN PACIFIC SHRIMPS OF THE GENUS PENAEUS ...Animal Taxonomy, Pacific Ocean-general, Range Or Territorial Distr. , Shrimps - Common, Vertical Distribution, ...5.0403

ECOLOGY AND TAXONOMY OF TROPICAL ATLANTIC SCOMBRID EGGS AND LARVAE ...Animal Distr. (non-specific), Animal Taxonomy, Basic Embryology, Food Supply, Tuna, Mackerel, Albacore... , ...5.0772

SURF CLAM BIOLOGY ...Age, Clams, Growth Rate, Reproductive System, Tags, ...5.0449

FISH POPULATION PARAMETERS ...Age, Biological Rhythms, Population Dynamics, Size, ...5.0039

SPECIES LIFE HISTORY AND DISTRIBUTION ...California Current, Fish -non-specific, Maturity & Growth Stages, Number Or Density, Oceanic Fronts, ...5.0037

THERMAL ACCLIMATION PATTERNS IN PARASITES AND HOSTS ...Adaptation, Host Resistance, Host Specificity, Monogenea, Water Temperature-non-specific, ...5.0643

MARINE ANIMAL USE IN THE STUDY OF HEALTH PROBLEMS ...Hormones, Hormones - Other, Metabolism, ...6.0126

Migration

BIOLOGICAL RESEARCH ON THE VOLCANIC ISLAND SURTSEY AND ENVIRON ...Iceland, Volcanoes, ...5.0889

SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES ...Behavior, Environmental Physiology, Fish -non-specific, Orientation, Sensory Organs, ...5.0338

THE ECOLOGY, MIGRATIONS AND BEHAVIOR OF MARINE TURTLES ...Behavioral Ecology, Reptile Studies - other, Spawning & Nesting Sites, Turtles, Terrapins, Tortoises, ...5.0586

PRODUCTIVITY OF OCEANIC POPULATIONS OF VERTICALLY MIGRATING ANIMALS ...Plankton (non-specific), Population Dynamics, Productivity (agricultural), Vertical Distribution, ...5.1019

SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES ...Behavior, Olfactory, Salmon & Trout - Non-specific, Visual Organs, ...5.0339

ECOLOGICAL INVESTIGATIONS OF MCMURDO SOUND ZOOPLANKTON ...Animal Taxonomy, Antarctica, Vertical Distribution, Zooplankton, ...5.0756

POPULATION DYNAMICS OF ANTARCTIC SEALS ...Aerial Photography, Antarctica, Population Dynamics, Seals, ...5.0634

ORIENTATION CUES AND PATTERNS OF LONG-DISTANCE TRAVEL OF MARINE TURTLES ...Biological Rhythms, Environmental Physiology, Orientation, Turtles, Terrapins, Tortoises, ...4.0102

DISTRIBUTION AND MIGRATION OF CENTRAL AMERICAN FRESHWATER ELASMOBRANCHS ...Caribbean Sea, Nicaragua, Osmoregulation, Rays, Skates, Mantas, Sawfish, Sharks, ...5.0117

WALRUS BIOLOGY AND POPULATION ...Behavioral Ecology, Censusing, Population Dynamics, Reproduction Studies (general), Seals, ...5.0523

INVESTIGATION OF ANADROMOUS DOLLY VARDEN POPULATIONS IN HOOD BAY DRAINAGES, SOUTHEASTERN ALASKA ...Alaska, Lake Trout, Brook Trout, Population Dynamics, Streams, ...5.0013

TAGGING ENGLISH SOLE, PETRALE SOLE, AND PACIFIC COD ...Codfishes, Hake, Commercial Fishing, Righteye Flounders, Size, Tags, Washington, ...5.0158

KVICHAK RIVER TOTAL SMOLT ...Alaska, Censusing, Fish - non-specific, Mortality Rates, Nets, Population Dynamics, ...5.0002

COOK INLET ESCAPEMENT ENUMERATION STUDY ...Alaska, Censusing, Organism Sampling Devices, Salmon - coho,chinook,sockeye.., Sonar, Sonar and Echo Sounding, ...8.0112

A STUDY OF THE RATE AND PATTERN OF SHAD MIGRATION IN THE CONNECTICUT RIVER UTILIZING SONIC TRACKING APPARATUS ...Alewife,menhaden,shad,herring, Connecticut River, Spawning & Nesting Sites, Tags, Telemetry, ...5.0046

SOCKEYE SALMON MIGRATORY BEHAVIOR AND BIOLOGICAL STATISTICS COLLECTION, SOUTHEASTERN ALASKA ...Alaska, Behavioral Ecology, Censusing, Salmon -coho,chinook,sockeye.., Streams, ...5.0027

COPPER RIVER SOCKEYE SALMON INVESTIGATIONS ...Alaska, Aquatic Ecology, Biological Rhythms, Population Dynamics, Salmon -coho,chinook,sockeye.., Stocking of Fish & Shellfish, ...5.0025

COPPER RIVER SOCKEYE SALMON INVESTIGATIONS ...Alaska, Commercial Fishing, Nets, Salmon -coho,chinook,sockeye.., Streams, ...5.0026

SOCKEYE SALMON MIGRATORY BEHAVIOR AND BIOLOGICAL STATISTICS COLLECTION, SOUTHEASTERN ALASKA ...Alaska, Aquatic Ecology, Behavioral Ecology, Censusing Salmon -coho,chinook,sockeye.., ...5.0016

TAG RECOVERY, ENGLISH SOLE, PETRALE SOLE, AND PACIFIC COD ...Codfishes, Hake, Population Dynamics, Righteye Flounders, Tags, Washington, ...5.0159

KVICHAK RIVER SMOLT STUDY LITERATURE SURVEY ...Alaska, Censusing, Fish -non-specific, Number Or Density, Survey Studies, ...5.0003

COOK INLET CATCH AND ESCAPEMENT AGE AND SEX COMPOSITION STUDIES ...Age, Alaska, Nets, Salmon - coho,chinook,sockeye.., Sex -non-specific, Spawning & Nesting Sites, ...5.0014

FORECAST OF KODIAK ISLAND PINK SALMON RUNS FROM ABUNDANCE OF JUVENILES IN ESTUARIES ...Alaska, Estuaries, Fishing Gear, Maturity & Growth Stages, Number Or Density, Salmon -coho,chinook,sockeye.., ...5.0179

TAGGING SALMON IN THE OFFSHORE WATERS OF THE NORTH PACIFIC ...Bering Sea, Gulf of Alaska, Number Or Density, Range Or Territorial Distr. , Salmon & Trout - Non-specific, Tags, ...5.0180

FARMINGTON RIVER SHAD STUDIES ...Alewife,menhaden,shad,herring, Bottom Sampling, Captive Rearing, Sampling, Streams, ...5.0203

MOVEMENTS OF FRESHWATER CATFISH IN THE ESTUARIES OF SOUTHWEST LOUISIANA ...Blue Catfish, White Catfish, Environment Resistance, Estuaries, Louisiana, Water Salinity, ...5.0090

ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...Aquatic Ecology, Environmental Ecology, Estuaries, Fishing, Oregon, Population Dynamics, ...5.0216

MIGRATORY HABITS OF LARGE SHARKS ...Atlantic Ocean-north, Fishing, Sharks, Tags, ...5.0147

ABUNDANCE AND MIGRATION STUDIES OF THE WHITE SEAPERCH (P. FURCATUS), PILE PERCH (R. VACCA), STRIPED SEAPERCH (E. LATERALIS) AND STARRY FLOU ...Environmental Ecology, Fish -other, Number Or Density, Oregon, Righteye Flounders, ...5.0934

TRACKING MIGRATIONS OF BLUEFISH POPULATIONS ALONG ATLANTIC COAST TO LEARN BIOLOGY OF THE SPECIES (MIGRATORY HABITS OF BLUEFISH) ...Atlantic Ocean-north, Bluefish, Population Dynamics, Tags, ...5.0120

TAGGING PROGRAM WITH WOODS HOLE AND INTERNATIONAL GAME FISH ASSOCIATION FOR MARLIN, SAILFISH AND OTHER GAME SPECIES MIGRATION STUDIES ...Marlin, Billfishes, Sailfish.., Pacific Ocean-general, Population Dynamics, Tags, ...5.0036

EFFECT OF ENVIRONMENTAL CHANGES ON BLUE CRAB ABUNDANCE ...Crabs, Environmental Ecology, Life History Studies, Number Or Density, Population Dynamics, ...5.0473

TAGGING ...Alewife,menhaden,shad,herring, Population Dynamics, Tags, Telemetry, Vertebrate Anatomy, ...5.0127

BRISTOL BAY ESTUARINE ECOLOGY ...Alaska, Estuaries, Fishing Gear, Life History Studies, Oceanic Fronts, Salmon -coho,chinook,sockeye.., ...5.0004

NAKNEK SYSTEM RED SALMON STUDIES ...Alaska, Growth Rate, Number Or Density, Salmon -coho,chinook,sockeye.., Streams, ...5.0005

ADMINISTRATION OF WHALING ACT, PROTECTED AND NON-COMMERCIAL WHALES ...Censusing, Growth Rate, Mammals, Reproduction Studies (general), Vertebrate Anatomy, ...5.0669

COLLECTION OF JUVENILE MIGRANTS FROM RIVERS AND STREAMS ...Electric Power Plants, Engineering Structures-general, Fish -non-specific, Management -other, Streams, ...5.0513

JUVENILE MIGRATION RATES ...Columbia River, Mark, Tag Or Capture -other, Salmon & Trout - Non-specific, Snake River, Water Environment -other, ...5.0223

ADULT MIGRATION RATES ...Columbia River, Environmental Ecology, Management -other, Pre-impoundment Sites, Salmon -coho,chinook,sockeye.., ...5.0173

ELECTRIC BARRIER OPERATIONS ...Control of Nuisance Species, Lake Michigan, Lake Superior, Lampreys, Population Dynamics, ...5.0630

MIGRATION OF ATLANTIC TUNAS ...Africa, Atlantic Ocean-general, Tags, Tuna, Mackerel, Albacore... , ...5.0064

BERING SEA KING CRAB STUDIES ...Bering Sea, Commercial Fishing, Crabs, Environmental Ecology, ...5.0341

ADULT SALMON BEHAVIOR STUDIES IN RIVERS AND AT DAMS %SONIC TRACKING40 ...Columbia River, Construction Land Use Effects, Pre-impoundment Sites, Salmon & Trout - Non-specific, Telemetry, ...5.0169

EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...Aquatic Ecology, Columbia River, Gases, Dissolved -water, Mortality Rates, Nitrogen, Salmon & Trout - Non-specific, ...5.0221

FISH TRANSPORTATION ...Aquatic Ecology, Management -other, Salmon & Trout - Non-specific, Streams, Tags, ...8.0013

FISH BEHAVIOR AND PHYSIOLOGY ...Behavior, Engineering Structures-general, Environmental Physiology, Salmon & Trout - Non-specific, Thermal Pollution, ...5.0331

FISHWAY RESEARCH (BONNEVILLE LABORATORY) ...Behavioral Ecology, Engineering Structures-general, Environmental Ecology, Management -other, Salmon & Trout - Non-specific, ...8.0016

PROTECTION OF FINGERLING SALMON IN TURBINES ...Construction Land Use Effects, Engineering Structures-general, Mortality Rates, Salmon & Trout - Non-specific, Snake River, ...8.0014

RECONNAISSANCE ECOLOGIC SURVEY OF THE CONTINENTAL SHELF AND UPPER SLOPE (GULF OCEANOGRAPHY PROGRAM) ...Behavioral Ecology, Biology, Continental Shelf, Environmental Ecology, Population Dynamics, Shrimps - Common, ...5.0502

AERIAL SEA SURFACE TEMPERATURE SURVEYS OF U S. COASTAL WATERS ...Aircraft, Infrared Radiation, Productivity - Food Chain, Temperature, Water Temperature-non-specific, ...4.0148

Population Dynamics

POPULATION STUDIES OF HAUSTORIIDAE AND GAMMARIDAE FROM NEW ENGLAND AND ON INFAUNAL AND EPIFAUNAL MARINE AMPHIPODS AT ENIWETOK ...Atolls, Habitat Studies, Micronesia, Shrimp - Amphipods, ...5.0466

RELATIONSHIPS AMONG POPULATIONS OF LIMNORIA TRIPUNCTATA ...Animal Taxonomy, Isopods, Reproductive System, ...5.0477

PRODUCTIVITY OF OCEANIC POPULATIONS OF VERTICALLY MIGRATING ANIMALS ...Migration, Plankton (non-specific), Productivity (agricultural), Vertical Distribution, ...5.1019

DEVELOPMENT AND EVALUATION OF A NEW TECHNIQUE FOR SAMPLING ZOOPLANKTON ...Organism Sampling Devices, Productivity - Food Chain, Technique Development, Vertical Distribution, Zooplankton, ...5.0786

SIMULATION STUDIES OF ECOLOGICAL COMMUNITIES ...Mortality Rates, Number Or Density, Predation, Productivity - Food Chain, ...5.0862

REPRODUCTIVE RELATIONSHIPS AMONG POPULATIONS OF A MARINE WOOD-BORING ISOPOD ...Animal Taxonomy, Invertebrate Anatomy, Isopods, Reproductive System, ...5.0414

MICROZOOPLANKTERS IN THE MARINE FOOD CHAIN ...Organism Sampling Devices, Productivity - Food Chain, Vertical Distribution, Zooplankton, ...5.0748

POPULATION DYNAMICS OF ANTARCTIC SEALS ...Aerial Photography, Antarctica, Migration, Seals, ...5.0634

PELAGIC SHARKS OFF SOUTHERN CALIFORNIA ...Environmental Ecology, Pacific Ocean-east, Sharks, Vertical Distribution, ...5.0196

ECOLOGY OF MARINE BIVALVE MOLLUSCAN LARVAE ...Behavioral Ecology, Clams, Fouling, Productivity - Food Chain, Vertical Distribution, ...5.0370

BIOMETRY ...Marine Biology, Navigation, Statistics-general, Temporal Distribution, ...4.0019

ARCTIC PLANKTON ECOLOGY ...Acoustical, Arctic, Marine Biology (non-specific), Oceanic Fronts, Plankton (non-specific), ...1.0017

DEEP SEA BENTHOS IN THE GULF OF MEXICO ...Benthic Fauna, Benthonic-bottom, Biology, Gulf of Mexico, ...5.0655

GULF OF CALIFORNIA BIOLOGY ...Arid and Desert, Bioluminescence, Gulf of California, Intertidal Areas, Tropic, ...5.0856

INTERACTIONS OF INTERTIDAL POPULATIONS ...Competition, Habitat Studies, Intertidal Areas, Predation, ...5.0864

BIOLOGIC SOUND SCATTERING ...Acoustical, Reverberation, Scattering, Vertical Distribution, Zooplankton, ...1.0060

MARINE BIOLOGY OF RED SEA AND EASTERN MEDITERRANEAN ...Benthic Flora, Mapping, Red Sea, ...5.0891

ECOLOGICAL INVESTIGATIONS OF SOME COMMON MARINE FISHES OFF THE MEDITERRANEAN COAST OF ISRAEL ...Fish -non-specific, Mediterranean Sea-general, Productivity - Food Chain, Range Or Territorial Distr. , ...5.0089

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...Aquatic Ecology, Estuaries, Mans Activities, Persistance of Residues, Pesticides -non-specific, Pollution - Effects of , Standing Crops, ...5.0880

SEA OTTER ...Alaska, Metamorphosis, Range Or Territorial Distr. , Sea Lions, Fur Seals, Stocking of Mammals, ...5.0528

WALRUS BIOLOGY AND POPULATION ...Behavioral Ecology, Censusing, Migration, Reproduction Studies (general), Seals, ...5.0523

POPULATION STUDIES OF ANADROMOUS FISH - UPPER COOK INLET DRAINAGES ...Alaska, Captive Rearing, Censusing, Salmon -coho,chinook,sockeye.., Streams, ...5.0020

CHEMICAL AND PHYSICAL DATA ...Fish -non-specific, Temperature, Turbidity & Suspended Matter, Water Movement, Currents,, Water Salinity, Water Temperature-non-specific, ...5.0207

INVESTIGATION OF ANADROMOUS DOLLY VARDEN POPULATIONS IN HOOD BAY DRAINAGES, SOUTHEASTERN ALASKA ...Alaska, Lake Trout, Brook Trout, Migration, Streams, ...5.0013

TRAMMEL NET SAMPLING IN ESTUARINE AREAS ...Competition, Estuaries, Fish -non-specific, Lakes, Nets, ...5.0096

FISH POPULATIONS IN THE CHENA RIVER ...Alaska, Pikes, Pickeral, Muskellunge, Salmon & Trout - Non-specific, Streams, ...5.0029

HAIR SEALS ...Age, Dispersion -other, Metamorphosis, Seals, Spawning & Nesting Sites, ...5.0525

SPORTFISH YIELD OF NATURAL REEFS ...Bays, California, Fishery Development -other, Habitat Studies, ...5.0199

ESTIMATION OF PARAMETERS OF STRIPED BASS POPULATION AND DESCRIPTION OF THE FISHERY OF LOWER CHESAPEAKE BAY ...Age, Basses -sea,white, White Perch, Censusing, Chesapeake Bay, Fishing Gear, ...5.0151

STUDY ON THE DISTRIBUTION AND ABUNDANCE OF PINK SHRIMP, PANDALUS JORDANI, IN THE PACIFIC OCEAN OFF OREGON ...Censusing, Fishing Gear, Life History Studies, Pacific Ocean-general, Shrimps - Common, ...5.0487

IDENTIFICATION OF WINTER FLOUNDER SUBPOPULATIONS ...Commercial Fishing, Legislation, Nets, Righteye Flounders, Tags, ...5.0100

KVICHAK RIVER TOTAL SMOLT ...Alaska, Censusing, Fish - non-specific, Migration, Mortality Rates, Nets, ...5.0002

SEA SURVEY INVESTIGATIONS ...California Current, Fish - non-specific, Survey Studies, Vertical Distribution, ...4.0117

KING CRAB SAMPLING GEAR STUDY ...Alaska, Censusing, Crabs, Fishing Gear, Spawning & Nesting Sites, ...8.0113

DUNGENESS CRAB POPULATION DYNAMICS STUDY ...Alaska, Crabs, Life History Studies, Tags, ...5.0346

ARCTIC-YUKON-KUSKOKWIM AREA ANADROMOUS FISH INVESTIGATIONS ...Alaska, Commercial Fishing, Life History Studies, Salmon & Trout - Non-specific, Salmon -coho,chinook,sockeye.., ...5.0024

MEASUREMENT OF BIOLOGICAL FACTORS OF VARIOUS HABITATS, AND THEIR RELATION TO THE BIOLOGY OF THE COMMERCIALLY IMPORTANT SPECIES ...Chemical Measurements -water, Habitat Studies, Physical Measurements - water, Plankton (non-specific), Productivity - Food Chain, ...5.0219

LIFE-HISTORY AND BIOLOGICAL WORK IN THE RESTORATION AND MANAGEMENT OD SPECIES OF IMPORTANCE TO THE FISHERIES OF THE VIRGIN ISLANDS ...Commercial Fishing, Diving and Scuba, Life History Studies, Management -other, Virgin Islands, ...5.0149

COPPER RIVER SOCKEYE SALMON INVESTIGATIONS ...Alaska, Aquatic Ecology, Biological Rhythms, Migration, Salmon -coho,chinook,sockeye.., Stocking of Fish & Shellfish, ...5.0025

TAG RECOVERY, ENGLISH SOLE, PETRALE SOLE, AND PACIFIC COD ...Codfishes, Hake, Migration, Righteye Flounders, Tags, Washington, ...5.0159

POPULATION STRUCTURE OF THE LOBSTER ...Commercial Fishing, Diving and Scuba, Lobsters, Long Island Sound, Size, ...5.0688

TAGGING PROGRAM ...Lobsters, Long Island Sound, Number Or Density, Tags, Temporal Distribution, ...5.0372

LAKE BORGNO - CHANDELEUR SOUND SYSTEM ...Data Acquisition, Gulf of Mexico, Maturity & Growth Stages, Nets, Plankton Sampling, Shrimps - Common, ...5.0434

BIOLOGICAL AND CHEMICAL STUDY OF VIRGINIA'S ESTUARIES ...Estuaries, Nitrogen, Phosphorus, Phytoplankton, Primary Productivity, Virginia, ...1.0158

STUDIES OF SOCKEYE SALMON, ONCORHYNCHUS NERKA, IN THE NUSHAGAK DISTRICT, ALASKA ...Alaska, Commercial Fishing, Interbiotic Relat.(non-specif), Lakes, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, ...5.0228

REPOPULATION OF DECIMATED SECTIONS OF WARMWATER STREAMS BY LONGEAR SUNFISH, LEPOMIS MEGALOTIS (RAFINESQUE) ...Aquatic Ecology, Stocking of Fish & Shellfish, Streams, Sunfish, Rock & Roanoke Bass.., Warm Water, ...5.0097

A NON-DESTRUCTIVE METHOD FOR ESTIMATING POPULATION DENSITY AND DISTANCE TO NEAREST NEIGHBOR FOR ESTUARINE MOLLUSCS ...Aquatic Ecology, Estuaries, Mollusks -non-specific & Other, Number Or Density, Range Or Territorial Distr. , ...5.0439

THE POPULATION ECOLOGY OF GEMMA GEMMA (PELECYPODA, VENERIDAE), A DOMINANT SPECIES IN BARNSTABLE HARBOR, MASS ...Clams, Harbors, Massachusetts, ...5.0460

MARINE SPORTS FISHES RESEARCH ...Delaware Bay, Fish - other, Killifishs - Cyprinodon, Water Salinity, Water Temperature-non-specific, ...5.0248

ECOLOGY OF COMMERCIAL FISH SPECIES IN NORTHERN LAKE MICHIGAN ...Commercial Fishing, Fish -non-specific, Lake Michigan, Number Or Density, Vertical Distribution, ...5.0112

INVESTIGATION OF COMMERCIAL FISH POPULATIONS IN WESTERN LAKE SUPERIOR ...Alewife,menhaden,shad,herring, Commercial Fishing, Lake Superior, Lakes, Nets, ...5.0113

ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...Aquatic Ecology, Environmental Ecology, Estuaries, Fishing, Migration, Oregon, ...5.0216

EFFECTS OF KRAFT PULP MILL EFFLUENTS ON THE GROWTH AND PRODUCTION OF FISH ...Contamination - Water, Industrial Wastes, Pollution - Effects of , Pollution Effects, Pulp, Paper , and Logging, Salmon & Trout - Non-specific, ...5.0311

POPULATION ESTIMATES OF JUVENILE COHO SALMON IN SIX COASTAL STREAMS ...Environmental Ecology, Maturity & Growth Stages, Salmon -coho,chinook,sockeye.., Streams, ...5.0144

INFAUNA OF LOWER CHESAPEAKE BAY ...Aquatic Ecology, Chesapeake Bay, Shrimp - Amphipods, Streams, Virginia, ...5.0661

MOVEMENTS OF SEABIRDS IN THE HUMBOLDT CURRENT ...Aves -other, Biological Rhythms, Humboldt Or Peru Current, Temporal Distribution, ...5.0583

LIFE HISTORY AND BEHAVIOR OF FISHES ON ARTIFICAL REEFS ...Behavioral Ecology, Fish -non-specific, Habitat Studies, Life History Studies, ...5.0121

TRACKING MIGRATIONS OF BLUEFISH POPULATIONS ALONG ATLANTIC COAST TO LEARN BIOLOGY OF THE SPECIES (MIGRATORY HABITS OF BLUEFISH) ...Atlantic Ocean-north, Bluefish, Migration, Tags, ...5.0120

TAGGING PROGRAM WITH WOODS HOLE AND INTERNATIONAL GAME FISH ASSOCIATION FOR MARLIN, SAILFISH AND OTHER GAME SPECIES MIGRATION STUDIES ...Marlin, Billfishes, Sailfish.., Migration, Pacific Ocean-general, Tags, ...5.0036

AGE AND GROWTH OF BLUEFISH ...Age, Atlantic Ocean-north, Bluefish, Growth Rate, Scales, ...5.0287

SURF CLAM POPULATION DYNAMICS ...Age, Clams, Commercial Fishing, Continental Shelf, Size, ...5.0448

FISH POPULATION STUDY ...Chemical Measurements -water, Commercial Fishing, Fish -non-specific, Food Supply, Water Temperature-non-specific, ...5.0174

ZOOPLANKTON OF THE GULF OF MAINE ...Atlantic Ocean-north, Plankton Sampling, Vertical Distribution, Zooplankton, ...5.0789

BIOSTATISTICS OF HERRING ...Age, Alewife,menhaden,shad,herring, Atlantic Ocean-north, Environmental Ecology, Growth Rate, Proprioceptors, ...5.0099

EFFECT OF ENVIRONMENTAL CHANGES ON BLUE CRAB ABUNDANCE ...Crabs, Environmental Ecology, Life History Studies, Migration, Number Or Density, ...5.0473

INVESTIGATION OF THE BIOLOGY AND POPULATION STRUCTURE OF GULF MENHADEN ...Alewife,menhaden,shad,herring, Bone, Gulf of Mexico, Handbooks, Vertebrate Anatomy, ...5.0128

POPULATION STUDIES ...Alewife,menhaden,shad,herring, Animal Distr. (non-specific), Animal Taxonomy, Environmental Ecology, ...5.0130

TAGGING ...Alewife,menhaden,shad,herring, Migration, Tags, Telemetry, Vertebrate Anatomy, ...5.0127

KARLUK LAKE RESEARCH STATION ...Life History Studies, Mortality Rates, Productivity (agricultural), Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, ...5.0006

GULF-PENINSULA KING CRAB STUDIES ...Commercial Fishing, Crabs, Gulf of Alaska, Habitat Studies, ...5.0342

GULF OF ALASKA DEMERSAL FISH INVESTIGATIONS ...Fish -non-specific, Gulf of Alaska, Productivity (agricultural), Vertical Distribution, ...5.0009

MARINE BIOLOGICAL INVESTIGATIONS - NEKTON OF INSIDE WATERS OF SOUTHEASTERN ALASKA ...Alaska, Plankton Sampling, Temporal Distribution, Zooplankton, ...5.0521

FUR SEAL RESEARCH, POPULATION DYNAMICS ...Age, Growth Rate, Life History Studies, Mark, Tag Or Capture - other, Seals, ...5.0671

POPULATION DYNAMICS OF NEW ENGLAND GROUNDFISH ...Atlantic Ocean-north, Codfishes, Hake, Lefteye Flounders, Rockfish, Scoraionfish, ...5.0103

POPULATION STRUCTURE OF THE ALEWIFE AND COREGONIDS ...Alewife,menhaden,shad,herring, Aquatic Ecology, Cisco, Lake Herring, Environmental Ecology, Lake Michigan, ...5.0106

LAKE ERIE INVESTIGATIONS - LIFE HISTORY AND ABUNDANCE OF THE YELLOW PERC ...Commercial Fishing, Environmental Ecology, Life History Studies, Nets, Yellow Perch, Darters, ...5.0134

SEA LAMPREY AMMOCETE REESTABLISHMENT STUDIES ...Aquatic Ecology, Control of Nuisance Species, Great Lakes-general, Lampreys, Larvicides, Life History Studies, ...5.0629

ELECTRIC BARRIER OPERATIONS ...Control of Nuisance Species, Lake Michigan, Lake Superior, Lampreys, Migration, ...5.0630

POPULATION DYNAMICS OF ATLANTIC TUNAS ...Atlantic Ocean-general, Censusing, Commercial Fishing, Tuna, Mackerel, Albacore... , ...5.0065

GREAT LAKES GEAR RESEARCH ...Commercial Fishing, Fish -non-specific, Fishing Gear, Great Lakes-general, Lakes, ...8.0136

DISTRIBUTION AND ABUNDANCE OF ZOOPLANKTON IN LAKE ERIE ...Aquatic Ecology, Computer Applications, Environmental Ecology, Interbiotic Relat.(non-specif), Lake Erie, ...5.0802

SHELLFISH EXPLORATIONS ...Benthic Fauna, Clams, Commercial Fishing, Mark, Tag Or Capture -other, ...5.0514

SEA CLAM EXPLORATIONS ...Animal Distr. (non-specific), Atlantic Ocean-north, Clams, Commercial Fishing, ...5.0456

STUDIES OF THE BENTHIC INVERTEBRATES OF THE ATLANTIC CONTINENTAL SHELF ...Atlantic Ocean-north, Benthic Fauna, Continental Shelf, Productivity - Food Chain, ...5.0623

LOBSTER RESEARCH ...Commercial Fishing, Environmental Ecology, Habitat Studies, Lobsters, ...5.0436

MARINE BIOLOGICAL INVESTIGATIONS STUDIES PROJECT (FISHES) ...Alaska, Aquatic Ecology, Bays, Fish -non-specific, ...5.0011

ESTUARINE ECOSYSTEMS ...Aquatic Ecology, Estuaries, Pesticides, Pollution - Effects of , Pollution Effects, ...5.0883

FISH POPULATION STUDY ...Analog Computer Applications, Environmental Ecology, Fish -other, Killifishs - Cyprinodon, Tilapia, Cichlids, ...5.0175

POPULATION DYANMICS (BIOMETRICS) OF EXPLOITED FISH GROUPS OF THE NORTH PACIFIC OCEAN AND PACIFIC COAST ...Marine Biology, Meteorological Studies, Model Studies, Number Or Density, Pacific Ocean-north, ...5.0167

GREAT LAKES EXPLORATIONS ...Commercial Fishing, Fish - non-specific, Fishing Gear, Great Lakes-general, ...5.0108

PREDICTING COMMERCIAL SHRIMP ABUNDANCE (SHRIMP DYNAMICS PROGRAM) ...Bays, Behavioral Ecology, Commercial Fishing, Environmental Ecology, Shrimps - Common, ...5.0499

EXPERIMENTAL SEEDING (SHRIMP AQUACULTURE PROGRAM) ...Captive Rearing, Florida, Shrimps - Common, Spawning & Nesting Sites, Stocking of Fish & Shellfish, ...5.0501

RECONNAISSANCE ECOLOGIC SURVEY OF THE CONTINENTAL SHELF AND UPPER SLOPE (GULF OCEANOGRAPHY PROGRAM) ...Behavioral Ecology, Biology, Continental Shelf, Environmental Ecology, Migration, Shrimps - Common, ...5.0502

POPULATION DYNAMICS (SHRIMP DYNAMICS PROGRAM) ...Commercial Fishing, Gulf of Mexico, Mortality Rates, Nets, Shrimps - Common, ...5.0503

INVESTIGATE TUNA SUBPOPULATIONS THROUGH THE USE OF BLOOD GROUPS AND INHERITED PROTEINS ...Blood Proteins -non-specific, Blood Typing Studies, Pacific Ocean-general, Tuna, Mackerel, Albacore... , ...5.0076

DEVELOP TECHNIQUES FOR CAPTURING JUVENILE TUNAS ...Blood Typing Studies, Nets, Tuna, Mackerel, Albacore... , Vertical Distribution, ...5.0078

INVESTIGATE POPULATION DYNAMICS OF ALBACORE ...American Samoa, Commercial Fishing, Tuna, Mackerel, Albacore... , Water Environment -other, ...5.0081

ASSESSMENT OF CENTRAL PACIFIC TUNA RESOURCES ...Commercial Fishing, Pacific Ocean-general, Size, Tuna, Mackerel, Albacore... , ...5.0082

INVESTIGATE TUNA RESOURCES OF THE TRUST TERRITORIES ...Caroline Islands, Commercial Fishing, Environmental Ecology, Tuna, Mackerel, Albacore... , ...5.0085

INVESTIGATE POPULATION DYNAMICS OF SKIPJACK TUNA IN HAWAIIAN WATERS ...Commercial Fishing, Economics, Environmental Ecology, Hawaii, Tuna, Mackerel, Albacore... , ...5.0083

FISH POPULATION PARAMETERS ...Age, Biological Rhythms, Life History Studies, Size, ...5.0039

SUBPOPULATIONS ...Anchovies, Commercial Fishing, Pacific Ocean-general, ...5.0042

INTERNATIONAL WEDDELL SEA OCEANOGRAPHIC EXPEDITION ...Organics, Primary Productivity, Productivity - Food Chain, Seals, Weddell Sea, ...4.0121

PHYSIOLOGICAL VARIATION AND ECOLOGY OF MOLLUSCS ...Energy Budgets, Gastropods -slugs,conch,snails, Metabolism, Reproductive System, Respiratory System, ...5.0472

Productivity - Food Chain

A NEW APPROACH TO NUTRITION, PHYSIOLOGY, AND MINERAL CYCLING OF FORAMINIFERA ...Axenic Culture, Foraminifera, Invertebrate Nutrition, Metabolism, ...5.0809

FIELD EXPERIMENTS ON THE FLUX OF RADIONUCLIDES THROUGH A SALT MARSH ECOSYSTEM ...Chlorideae (non-specific & Ot), Georgia, Model Studies, Swamps-marshes, Water Cycle, ...5.0965

MICROBIOLOGICAL ASSAYS OF SEAWATER USING RADIOISOTOPES ...Aquatic Ecology, Ciliates, Environmental Ecology, Environmental Physiology, Food Chains, Phytoplankton, Thiamine, ...5.0811

BIOLOGY AND CHEMISTRY OF MARINE PLANKTON POPULATIONS ...Buoys, Chlorophyll, Phytoplankton, Vertical Distribution, Zooplankton, ...5.0798

THE BIOLOGY AND CHEMISTRY OF TRACE ELEMENTS IN MARINE AND ESTUARINE WATERS ...Chesapeake Bay, Estuaries, Phytoplankton, Trace Element Analysis, Zooplankton, ...5.0975

BIOLOGICAL PRODUCTIVITY IN THE SARGASSO SEA, THE GULF STREAM AND IN THE ATLANTIC COASTAL WATERS OFF CAPE HATTERAS ...Continental Shelf, Phytoplankton, Primary Productivity, Proteins, ...5.1005

SEASONAL DISTRIBUTION AND ABUNDANCE OF DEMERSAL FISH AND INVERTEBRATES IN THE MARINE WATERS ADJACENT TO THE MOUTH OF THE COLUMBIA RIVER ...Benthic Fauna, Number Or Density, Radioactivity-general, Temporal Distribution, Vertical Distribution, ...5.0930

UPTAKE AND ASSIMILATION OF ORGANIC COMPOUNDS IN MARINE ORGANISMS ...Active Transport, Invertebrates - non-specific, Metabolism, Nutrition, Organics, ...5.0937

DISTRIBUTION AND BIOLOGY OF PACIFIC ZOOPLANKTON ...Animal Taxonomy, Pacific Ocean-general, Range Or Territorial Distr. , Vertical Distribution, Zooplankton, ...5.0745

ECOLOGICAL AND EVOLUTIONARY IMPLICATIONS OF THE ECOTYPES OF ESTUARINE CRUSTACEA ...Classical, Estuaries, Invertebrate Anatomy, Isopods, Metabolism, ...5.0418

ECOLOGY OF THE PORITES FURCATA REEF-FLAT COMMUNITY ...Anthozoa, Panama, Puerto Rico, Reefs, ...5.0867

DEVELOPMENT AND EVALUATION OF A NEW TECHNIQUE FOR SAMPLING ZOOPLANKTON ...Organism Sampling Devices, Population Dynamics, Technique Development, Vertical Distribution, Zooplankton, ...5.0786

SIMULATION STUDIES OF ECOLOGICAL COMMUNITIES ...Mortality Rates, Number Or Density, Population Dynamics, Predation, ...5.0862

EXPERIMENTAL STUDIES ON THE BIOLOGY AND FOOD CHAIN ECONOMICS OF THE CHAETOGNATHS ...Energy Budgets, Reproductive System, Whole Body Culture & Rearing, Zooplankton, ...5.0777

STANFORD BIOLOGICAL OCEANOGRAPHY ...Marine Biology, Phytoplankton, Primary Productivity, Ships and Cruises, Training Grants, Fellowships, Zooplankton, ...11.0005

DIVERSITY, COMMUNITY STRUCTURE AND TROPHIC RELATIONS OF TROPICAL ZOOPLANKTON ...Bays, Inter-biotic Relat.(non,specif), Tropic, Zooplankton, ...5.0785

THE INFLUENCE OF DEPOSIT FEEDING BENTHOS ON THE STABILITY OF BOTTOM SEDIMENTS AND COMMUNITY TROPHIC STRUCTURE ...Benthic Fauna, Benthonic-bottom, Massachusetts, Suspension, ...5.0559

METABOLISM OF MARINE ECOSYSTEMS ...Energy Budgets, Food Webs, Metabolism, Other, Plankton (non-specific), ...5.0966

THE ROLE OF COPROPHAGY IN MARINE FOOD CHAINS ...Feces, Invertebrate Nutrition, Nutrition -other, ...5.0963

MICROZOOPLANKTERS IN THE MARINE FOOD CHAIN ...Organism Sampling Devices, Population Dynamics, Vertical Distribution, Zooplankton, ...5.0748

BIOLOGICAL COLONIZATION OF A RECENTLY FORMED ISLAND ...Habitat Studies, Iceland, Islands, Succession, Volcanoes, ...5.0925

OPTIMUM ECOLOGICAL DESIGNS FOR ESTUARINE SYSTEMS OF NORTH CAROLINA ...Domestic Wastes-general, Estuaries, Marine Biology (non-specific), North Carolina, Pollution - Effects of , Pollution Effects, ...5.0913

LIPID COMPOSITION OF ANTARCTIC MARINE ORGANISMS AND SEA WATER ...Antarctic Ocean, Fish -non-specific, Gulf of Mexico, Lipids, Low Temp. -but Above 32f, Phytoplankton, Zooplankton, ...5.1031

THE EFFECTS OF SEAL AND FISH PREDATION ON CERTAIN ANTARCTIC BENTHIC COMMUNITIES ...Antarctica, Benthic Organisms (non-specif), Biology, Fish -non-specific, Predation, Seals, ...5.1039

BENTHIC COMMUNITIES ...Behavioral Ecology, Benthic Fauna, Bottom Sampling Device, Developmental Physiology, Fouling, Metabolism, ...5.0561

ECOLOGY OF MARINE BIVALVE MOLLUSCAN LARVAE ...Behavioral Ecology, Clams, Fouling, Population Dynamics, Vertical Distribution, ...5.0370

DRIFT-STATION BIOLOGY ...Alaska, Animal Taxonomy, Arctic Ocean, Oceanic Fronts, Sea Ice, ...5.0743

ECOLOGICAL INVESTIGATIONS OF SOME COMMON MARINE FISHES OFF THE MEDITERRANEAN COAST OF ISRAEL ...Fish -non-specific, Mediterranean Sea-general, Population Dynamics, Range Or Territorial Distr. , ...5.0089

MEASUREMENT OF BIOLOGICAL FACTORS OF VARIOUS HABITATS, AND THEIR RELATION TO THE BIOLOGY OF THE COMMERCIALLY IMPORTANT SPECIES ...Chemical Measurements -water, Habitat Studies, Physical Measurements -water, Plankton (non-specific), Population Dynamics, ...5.0219

PRODUCTIVITY STUDIES IN NORTH CAROLINA SALT MARSHES ...Aerial Photography, Mapping, North Carolina, Primary Productivity, Swamps-marshes, Tidewater Areas, ...5.1017

MARINE WASTE DISPOSAL AND SEA URCHIN ECOLOGY ...California, Pollution Effects, Sea Urchins & Other Echinoderm, Sewage, ...5.0551

BIONOMICS OF FISHES AND SHELLFISHES ...Aquaculture & Fish-farming, Bays, Economics-general, Environmental Ecology, Oregon, ...5.0920

PLANKTON ECOLOGY OF BAR-BUILT ESTUARIES ...Estuaries, North Carolina, Phytoplankton, Primary Productivity, Zooplankton, ...5.0816

ECOLOGY OF SABELLARIID REEFS IN DELAWARE BAY ...Aquatic Ecology, Delaware Bay, Environmental Ecology, Lugworms, Marine Segmentedworm, Vertical Distribution, ...5.0871

ECOLOGY OF MARSH FORAMINIFERA ...Foraminifera, Lagoons, Rate of Deposition, Swamps-marshes, ...5.0747

PRIMARY PRODUCTIVITY IN PUERTO GALERA BAY, MINDORO, PHILIPPINES ...Bays, Philippines, Primary Productivity, ...5.1025

MARINE BIOLOGY PROGRAM ...Distribution, Puerto Rico, Radioecology, Rare Earths, Trace Elements, ...1.0128

BIOCHEMICAL AND BIOPHYSICAL STUDIES OF THE MARINE ENVIRONMENT ...Copepods, Energy, Energy Budgets, Organics, ...5.0767

ECOLOGY OF PANAMANIAN REEF COMMUNITIES ...Behavioral Ecology, Invertebrates -non-specific, Panama, Reefs, Tropic, ...5.0866

CORAL ATOLL ECOLOGY ...Anthozoa, Atolls, Bibliography, Data Analysis - General, ...5.0872

PHYSIOLOGY AND ECOLOGY OF THE ADRIATIC BENTHOS ...Adriatic Sea, Benthic Organisms (non-specif), Marine Biology (non-specific), Metabolism, Microclimate-general, ...5.0873

SAND DOLLAR COMMUNITIES ...Beaches, California, Habitat Studies, Sea Urchins & Other Echinoderm, ...5.0533

ECOLOGY AND DISTRIBUTION OF OYSTERS AND CLAMS ...Animal Distr. (non-specific), Clams, Oysters, Ponds, ...5.0446

SEDIMENT MINERALOGY (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Adsorption, Chemistry, Food Webs, Radioactivity, Radioactivity-general, ...7.0077

PHYSIOLOGY AND BEHAVIOR ...Behavior, Chemical Measurements -water, Environmental Physiology, Lake Michigan, Physical Measurements -water, ...5.0904

CHEMICAL CHARACTERISTICS OF THE GREAT LAKES ...Chemical Analysis (water), Great Lakes-general, Nutrients, Water Quality-general, ...1.0116

FEEDING HABITS OF ATLANTIC TUNAS AND NEKTON ECOLOGY ...Atlantic Ocean-general, Food Supply, Plankton (non-specific), Tuna, Mackerel, Albacore... , ...5.0204

RELATION OF ENVIRONMENTAL FACTORS TO THE PRODUCTIVITY OF ESTUARINE SEDENTARY FAUNA ...Aquatic Ecology, Environmental Ecology, Estuaries, Florida, ...5.0959

MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ORGANISMS ...Chlorinated Hydrocarbons, Food Chains, Animal And/or Man, Insecticides -non-specific, Pollution Effects, ...6.0155

STUDIES OF THE BENTHIC INVERTEBRATES OF THE ATLANTIC CONTINENTAL SHELF ...Atlantic Ocean-north, Benthic Fauna, Continental Shelf, Population Dynamics, ...5.0623

BIOLOGICAL OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM) ...Environmental Ecology, Food Supply, Gulf of Mexico, Shrimps - Common, ...5.0838

PRIMARY PRODUCTIVITY ...Marine Plants, Primary Productivity, Standing Crops, ...5.0955

DESCRIPTIVE PHYSICAL OCEANOGRAPHY OF THE EASTERN TROPICAL ATLANTIC ...Atlantic Ocean-general, Environmental Ecology, Fish -non-specific, Tropic, ...4.0127

PRODUCTIVITY MEASURES ...Number Or Density, Ocean Currents-other, Organism Sampling Devices, Pacific Ocean-east, Primary Productivity, Zooplankton, ...5.0940

INTERNATIONAL WEDDELL SEA OCEANOGRAPHIC EXPEDITION ...Organics, Population Dynamics, Primary Productivity, Seals, Weddell Sea, ...4.0121

AERIAL SEA SURFACE TEMPERATURE SURVEYS OF U S. COASTAL WATERS ...Aircraft, Infrared Radiation, Migration, Temperature, Water Temperature-non-specific, ...4.0148

ENERGY TRANSFER IN LOWER MARINE TROPHIC LEVELS ...Aquatic Ecology, Energy Budgets, Environmental Ecology, Vertical Distribution, ...5.1020

Succession

BIOLOGICAL RESEARCH ON THE VOLCANIC ISLAND SURTSEY AND ENVIRON ...Iceland, Migration, Volcanoes, ...5.0889

BIOLOGICAL COLONIZATION OF A RECENTLY FORMED ISLAND ...Habitat Studies, Iceland, Islands, Productivity - Food Chain, Volcanoes, ...5.0925

ECOLOGICAL SUCCESSION ON SURTSEY ...Fouling, Iceland, Plant Succession, Volcanoes, ...5.0890

SUCCESSION, SPACIAL AND TEMPORAL DISTRIBUTION, AND BIOLOGY OF BENTHIC ORGANISMS ...Benthic Fauna, Benthic Flora, Temporal Distribution, ...5.0638

Terrestrial Ecology

ECOLOGY OF STORM PETRELS ...Albatrosses, Shearwaters... , California, Islands, Mark, Tag Or Capture -other, Spawning & Nesting Sites, ...5.0532

Ecology (plant)

Applied Ecology

AN ECOLOGICAL STUDY OF SOUTH BISCAYNE BAY IN THE VICINITY OF TURKEY POINT ...Balance of Nature, Bays, Electric Power Plants, Environmental Ecology, Florida, Phytoplankton, Thermal Pollution, ...5.0877

RESTORATION, PROPAGATION, AND MANAGEMENT OF MARINE ALGAE ...Growth and Differentiation, Habitat Studies, Laminariaceae (non-specif.&ot), Marine Plants, Pacific Ocean-east, ...5.0680

Aquatic Plant Group

Aquatic Plants (non-specific)

QUANTITATIVE AND QUALITATIVE MEASUREMENT OF AQUATIC VEGETATION-CURRITUCK SOUND ...Estuaries, Range Or Territorial Distr. , Saline Water Intrusion, Salinity, Vertical Distribution, ...5.0717

Lower Plants

DISSOLVED ORGANIC PHOSPHORUS IN NATURAL WATERS ...Phosphorus, Phytoplankton, Water Analysis, ...1.0123

Submerged Plants

ECOLOGICAL STUDIES OF THE SOUTHEASTERN FLORIDA SEA GRASS COMMUNITY - PRIMARY PRODUCTION BY THALASSIA TESTUDINUM KONIG ...Elodea, Waterweed, Thalassia, Florida, Primary Productivity, Translocation, Tropic, ...5.0695

Balance of Nature

AN ECOLOGICAL STUDY OF SOUTH BISCAYNE BAY IN THE VICINITY OF TURKEY POINT ...Applied Ecology, Bays, Electric Power Plants, Environmental Ecology, Florida, Phytoplankton, Thermal Pollution, ...5.0877

Biomes

Rain Forests

SUPPORT FOR THE PHYSIOLOGICAL RESEARCH SHIP, R/V ALPHA HELIX ...Insecticides -non-specific, Mycorrhiza, Nerve Effects, Regulation, Tropic, ...12.0011

Distribution

Plant Distr. (non-specific)

MARINE BACTERIAL ENZYMES ...Cell. env.(non-specific & Ot.), Growth (non-specific & Ot.), Isolation From Nat. environ. , Marine Bacteria, Proteolytic Enzymes, ...5.0824

Range Or Territorial Distr.

MICROBIAL ACTIVITY IN NON AQUEOUS SYSTEMS ...Growth Rate, ...5.0782

SYSTEMATICS, MORPHOLOGY, AND ECOLOGICAL DISTRIBUTION OF ALGO AND WOOD-INHABITING MARINE AND FRESHWATER FUNGI OF SURTSEY AND ICELAND ...Aquatic Fungi (non-specific), Iceland, Islands, Marine Fungi (non-specific), Plant Taxonomy, ...5.0714

TAXONOMY OF CALCAREOUS GREEN ALGAE ...Chlorophyceae (non-specif.&ot), Indian Ocean-general, Plant Morphology, Plant Taxonomy, Reproductive Physiology, ...5.0718

ECOLOGY OF PHYTOPLANKTON IN SEMI-TROPICAL ENVIRONMENTS ...Caribbean Sea, Phytoplankton, Sub - Tropic, Temporal Distribution, Vertical Distribution, ...5.0778

LANGMUIR CIRCULATION AND PLANKTON ECOLOGY ...Circulation-general, Phytoplankton, Vertical Distribution, Water Movement, Currents,, Wind Or Air Movement, Zooplankton, ...5.0794

STUDIES OF THE PHAEOPHYCEAN ORDERS CHORDARIALES AND PUNCTARIALES ...Algal Culture, Atlantic Ocean-north, Phaeophyta (non-specific & Ot), Temporal Distribution, ...5.0715

SYSTEMATICS AND ECOLOGY OF SUBTIDAL BENTHIC MARINE ALGAE ...Algae- General, Benthic Flora, Benthonic-bottom, Habitat Studies, Marine Plants, Plant Taxonomy, ...5.0701

MARINE SULFUR OXIDIZING BACTERIA ...Habitat Studies, Ions (inorganic), Isolation From Nat. environ. , Marine Bacteria, Thiobacillus, ...5.0758

LACUSTRINE AND ESTUARINE FUNGI ...Aquatic Fungi (non-specific), Host-parasite Interactions, Marine Fungi (non-specific), Phytoplankton, Plant Morphology, Plant Taxonomy, ...5.0731

BIOLOGY AND PALEONTOLOGY OF MARINE DINOFLAGELLATES AND HYSTRICHOSPHERES ...Algae-Dinoflagellates, Algal Culture, Cell Cycle, Plant Developmental Biology, Spores, Vertical Distribution, ...5.0799

DISTRIBUTION OF ANTARCTIC MARINE FUNGI ...Antarctica, Marine Fungi (non-specific), Phycomycetes, Plant Taxonomy, Ships and Cruises, Vertical Distribution, ...5.0694

PREDICTION OF BIOLOGICAL POPULATIONS FROM THE PHYSICAL OCEANIC ENVIRONMENT ...Marine Environments-general, Phytoplankton, Ships and Cruises, Temporal Distribution, Vertical Distribution, ...5.0844

AEGEAN SEA BIOLOGY ...Aegean Sea, Benthic Organisms (non-specif), Currents-longshore, Plankton (non-specific), Temporal Distribution, ...5.0887

BIOGRAPHIC STUDY OF THE BENTHOS OF PUERTO RICO AND THE VIRGIN ISLANDS ...Benthic Fauna, Benthic Flora, Benthonic-bottom, Currents-ocean, Temperature, Vertical Distribution, ...5.0652

QUANTITATIVE AND QUALITATIVE MEASUREMENT OF AQUATIC VEGETATION-CURRITUCK SOUND ...Aquatic Plants (non-specific), Estuaries, Saline Water Intrusion, Salinity, Vertical Distribution, ...5.0717

TAXONOMY AND ECOLOGY OF INSHORE MARINE MICROBIOTA ...Algae- General, Animal Taxonomy, Aquatic Ecology, Plant Taxonomy, Protozoa -other, ...5.0768

DISTRIBUTION OF CL. BOTULINUM E. IN FISH, SHELLFISH AND THE AQUATIC ENVIRONMENT IN OREGON ...Bacterial Culture, Clostridium Botulinum, Oregon, Virulence and Pathogenicity, ...5.0822

CORAL ATOLL FLORA ...Atolls, Floras, Plant Taxonomy, ...5.0692

BIOGEOGRAPHY OF BENTHONIC ORGANISMS ...Benthic Organisms (non-specif), Continental Shelf, Marine Biology (non-specific), Vertical Distribution, ...5.0876

NITRIFICATION BY MARINE MICROORGANISMS ...Autotrophic, Bact. morphology (general), Bacterial Culture, Isolation From Nat. environ. , Marine Bacteria, Nitrogen Bacteria, ...5.0800

STUDIES ON THE PROTISTAN CAUSING MALPEQUE DISEASE ...Invertebrate Pathology, Myxomycetes, Oysters, Pathology, Plant Taxonomy, ...5.0498

Temporal Distribution

ECOLOGY OF TROPICAL DEEP WATER ALGAE ...Algae-General, Benthic Flora, Diving and Scuba, Plant Succession, Tropic, Vertical Distribution, ...5.0722

ECOLOGY OF PHYTOPLANKTON IN SEMI-TROPICAL ENVIRONMENTS ...Caribbean Sea, Phytoplankton, Range Or Territorial Distr. , Sub - Tropic, Vertical Distribution, ...5.0778

STUDIES OF THE PHAEOPHYCEAN ORDERS CHORDARIALES AND PUNCTARIALES ...Algal Culture, Atlantic Ocean-north, Phaeophyta (non-specific & Ot), Range Or Territorial Distr. , ...5.0715

PREDICTION OF BIOLOGICAL POPULATIONS FROM THE PHYSICAL OCEANIC ENVIRONMENT ...Marine Environments-general, Phytoplankton, Range Or Territorial Distr. , Ships and Cruises, Vertical Distribution, ...5.0844

BIOLOGICAL OCEANOGRAPHY ...Arctic, Organics, Phytoplankton, ...5.1038

AEGEAN SEA BIOLOGY ...Aegean Sea, Benthic Organisms (non-specif), Currents-longshore, Plankton (non-specific), Range Or Territorial Distr. , ...5.0887

SUCCESSION, SPACIAL AND TEMPORAL DISTRIBUTION, AND BIOLOGY OF BENTHIC ORGANISMS ...Benthic Fauna, Benthic Flora, ...5.0638

SEASONAL VARIATIONS OF ALGAL POPULATIONS ...Algae- General, Algal Culture, Nutrition Studies, ...5.0705

Vertical Distribution

BIOLOGY AND CHEMISTRY OF MARINE PLANKTON POPULATIONS ...Buoys, Chlorophyll, Phytoplankton, Zooplankton, ...5.0798

ECOLOGY OF TROPICAL DEEP WATER ALGAE ...Algae-General, Benthic Flora, Diving and Scuba, Plant Succession, Temporal Distribution, Tropic, ...5.0722

ECOLOGY OF PHYTOPLANKTON IN SEMI-TROPICAL ENVIRONMENTS ...Caribbean Sea, Phytoplankton, Range Or Territorial Distr. , Sub - Tropic, Temporal Distribution, ...5.0778

THE CHARACTERISTICS, MECHANISMS AND BIOGEOCHEMICAL CONSEQUENCES OF PHYTOPLANKTON FLOTATION ...Organics, Phytoplankton, Plant Lipids, Silicon, Size, ...5.0826

RELATIONSHIPS BETWEEN PHYTOPLANKTON AND ZOOPLANKTON IN THE CARIBBEAN SEA ...Caribbean Sea, Interbiotic Relat.(non-specif), Phytoplankton, Sargassum, Zooplankton, ...5.0779

BIOLOGY AND PALEONTOLOGY OF MARINE DINOFLAGELLATES AND HYSTRICHOSPHERES ...Algae-Dinoflagellates, Algal Culture, Cell Cycle, Plant Developmental Biology, Range Or Territorial Distr. , Spores, ...5.0799

DISTRIBUTION OF ANTARCTIC MARINE FUNGI ...Antarctica, Marine Fungi (non-specific), Phycomycetes, Plant Taxonomy, Range Or Territorial Distr. , Ships and Cruises, ...5.0694

PREDICTION OF BIOLOGICAL POPULATIONS FROM THE PHYSICAL OCEANIC ENVIRONMENT ...Marine Environments-general, Phytoplankton, Range Or Territorial Distr. , Ships and Cruises, Temporal Distribution, ...5.0844

QUANTITATIVE AND QUALITATIVE MEASUREMENT OF AQUATIC VEGETATION-CURRITUCK SOUND ...Aquatic Plants (non-specific), Estuaries, Range Or Territorial Distr. , Saline Water Intrusion, Salinity, ...5.0717

A STUDY OF COLIFORM BACTERIA AND ESCHERICHIA COLI ON POLLUTED AND UNPOLLUTED OYSTER BOTTOMS OF MISSISSIPPI ...Coliforms (non-specific), Identification, Mississippi River, Sampling, Sewage, ...5.0465

BIOLOGICAL OCEANOGRAPHY & DETERIORATION - SHALLOW WATER MARINE SEDIMENTS & WATER COLUMN BACTERIA ...Biology, Continental Shelf, Instrumentation-general, Marine Bacteria, Nephelometry, ...5.0807

ECOLOGY OF CLOSTRIDIUM BOTULINUM TYPE E IN GREEN BAY ...Fish -non-specific, Great Lakes-general, Microbiological, ...5.0850

Ecological Types -other

ECOLOGICAL STUDIES OF THE MARINE RED ALGA CHONDRUS CRISPUS STACKHOUSE ...Ag Uses of Nat. resource-other, Algal Culture, Chondrus, Growth and Differentiation, Reproductive Physiology, ...5.0710

THE OCCURRENCE AND EFFECTS OF PLANKTON IN THE SEA ...Air-sea Boundary-general, Marine Biology, Plankton (non-specific), ...5.0781

THE ECOLOGICAL ARCHITECTURES OF THE MARINE BIOSPHERE ...Marine Biology, Marine Biology (non-specific), ...5.0859

Ecosystems

Plant Ecosystems(non-specific)

ORGANIC PRODUCTION OF EPIFAUNAL ORGANISMS ...Energy Budgets, Epiphytic Relationships, Marine Biology (non-specific), Organics, Primary Productivity, Reefs, ...5.1032

Plant Succession

ECOLOGY OF TROPICAL DEEP WATER ALGAE ...Algae-General, Benthic Flora, Diving and Scuba, Temporal Distribution, Tropic, Vertical Distribution, ...5.0722

PALEOBTANICAL RESEARCH AT YALE UNIVERSITY ...Growth Rate, Isolation From Nat. environ. , Marine Bacteria, Plants, Sulfur Bacteria, ...5.0952

ECOLOGICAL SUCCESSION ON SURTSEY ...Fouling, Iceland, Succession, Volcanoes, ...5.0890

BIOCHEMISTRY OF MARINE ORGANISMS ...Adsorption & Interface, Bioluminescence, Fouling, Phytoplankton, Spectroscopy, ...5.0766

Epiphytic Relationships

ORGANIC PRODUCTION OF EPIFAUNAL ORGANISMS ...Energy Budgets, Marine Biology (non-specific), Organics, Plant Ecosystems(non-specific), Primary Productivity, Reefs, ...5.1032

Floras

CORAL ATOLL FLORA ...Atolls, Plant Taxonomy, Range Or Territorial Distr. , ...5.0692

Food Chains

THE ACCUMULATION OF FISSION PRODUCTS BY MARINE FISH AND SHELLFISH ...Chlorideae (non-specific & Ot), Contamination - Water, Estuaries, Radioactivity-general, Radioecology, ...6.0167

EFFECTS OF INGESTION OF RADIOACTIVE FISH AND THE NATURE AND BIOLOGY OF TOXINS IN CERTAIN FISHES ...Fish -non-specific, Food (epidemiology), Radioactive Isotopes, Toxicological and Allergy, ...6.0108

MICROBIOLOGICAL ASSAYS OF SEAWATER USING RADIOISOTOPES ...Aquatic Ecology, Ciliates, Environmental Ecology, Environmental Physiology, Phytoplankton, Productivity - Food Chain, Thiamine, ...5.0811

ALGAL SUBSTANCES IN THE MARINE FOOD WEB ...Food Webs, Humic Acid, Marine Plants, Phaeophyta (non-specific & Ot), Phenols, Secretions and Products, ...5.0725

Food Webs

METABOLISM OF MARINE ECOSYSTEMS ...Energy Budgets, Metabolism, Other, Plankton (non-specific), Productivity - Food Chain, ...5.0966

ALGAL SUBSTANCES IN THE MARINE FOOD WEB ...Food Chains, Humic Acid, Marine Plants, Phaeophyta (non-specific & Ot), Phenols, Secretions and Products, ...5.0725

ECOLOGY OF EELGRASS ...Alaska, Bering Sea, Phytoplankton, Potamogeton, Ruppia, Zostera.., Primary Productivity, ...5.0677

SEDIMENT MINERALOGY (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Adsorption, Chemistry, Productivity - Food Chain, Radioactivity, Radioactivity-general, ...7.0077

Habitat Studies

MARINE ALGAE OF THE MANGROVE ROOT COMMUNITY ...Algae- General, Mangroves, Marine Plants, Puerto Rico, Roots, ...5.0723

MORPHOLOGY AND TAXONOMY OF MARINE FUNGI ...Mangroves, Marine Fungi (non-specific), Plant Morphology, Plant Taxonomy, Sub - Tropic, Tropic, ...5.0716

TROPHIC RELATIONSHIPS IN SHOAL BENTHIC ENVIRONMENTS ...Benthic Flora, Biology, Estuaries, New England Province, ...5.1027

SYSTEMATICS AND ECOLOGY OF SUBTIDAL BENTHIC MARINE ALGAE ...Algae- General, Benthic Flora, Benthonic-bottom, Marine Plants, Plant Taxonomy, Range Or Territorial Distr. , ...5.0701

MARINE SULFUR OXIDIZING BACTERIA ...Ions (inorganic), Isolation From Nat. environ. , Marine Bacteria, Range Or Territorial Distr. , Thiobacillus, ...5.0758

PHYSIOLOGY AND ECOLOGY OF MARINE DIATOMS ...Algae- Diatoms, Algal Culture, Marine Plants, Nutrition Studies, Physiological Ecology, Plant Taxonomy, ...5.0735

ECOLOGY OF MARINE ENDOLITHIC ALGAE ...Algae-General, Borings - Tracks - Trails, Calcium, Niches, Textures-structures, ...5.0690

SUPPORT OF THE VERMILION SEA FIELD STATION AT BAHIA DE LOS ANGELES, BAJA CALIFORNIA ...Arid and Desert, Facilities, Gulf of California, Temperature, Tides, ...12.0009

RESTORATION, PROPAGATION, AND MANAGEMENT OF MARINE ALGAE ...Applied Ecology, Growth and Differentiation, Laminariaceae (non-specif.&ot), Marine Plants, Pacific Ocean-east, ...5.0680

GEOMICROBIOLOGICAL WEATHERING PHENOMENA OFF ANVERS ISLAND ...Antarctica, Identification, Marine Bacteria, Petrography, Weathering, ...7.0232

ECOLOGICAL STUDIES OF ROCKY SUBTIDAL AREAS ...Animal Taxonomy, Marine Plants, Plant Taxonomy, ...5.0865

THE EFFECTS OF POLLUTION ON BENTHIC MARINE PLANT COMMUNITIES ...Bays, Water Depth, Water Levels, ...5.0724

EXPERIMENTAL ECOLOGY OF LOWER MARINE FUNGI ...Marine Fungi (non-specific), Phycomycetes, Plant Developmental Biology, ...5.0808

ENERGETICS OF PALAEMONETES PUGIO AND THE WEEDBED COMMUNITY OF SOUTH CREEK ESTUARY ...Aquatic Vegetation -ns, Energy Budgets, Estuaries, North Carolina, Shrimps - Common, ...5.0482

PRESERVATION OF WOODS IN THE MARINE ENVIRONMENT ...Biological, Fouling, Marine Fungi (non-specific), Materials Used Undersea, Preservatives, Wood, ...8.0216

FILM PROJECT (KELP FORESTS) ...California, Cinematography, Fishery Development -other, Laminariaceae (non-specif.&ot), ...5.0678

ECOLOGY OF THE KELP FORESTS ...Behavioral Ecology, California, Environmental Ecology, Fish -non-specific, Laminariaceae (non-specif.&ot), ...5.0194

ENVIRONMENTAL CONDITIONS AND POPULATION DYNAMICS IN SELECTED UNPOLLUTED ESTUARIAL

AND COASTAL AREAS ...Aquatic Ecology, Contamination - Water, Marine Biology (non-specific), Pollution - Effects of , Toxic Substances -non-specific, ...5.0922

WATER QUALITY AND FUNGI-NEMATODE-SEAGRASS RELATIONSHIPS ...Elodea, Waterweed, Thalassia, Florida, Marine Fungi (non-specific), Nematoda -other, ...5.0878

Mapping

BIOLOGICAL RESEARCH ON THE VOLCANIC ISLAND SURTSEY AND ENVIRON ...Iceland, Migration, Volcanoes, ...5.0889

MARINE BIOLOGY OF RED SEA AND EASTERN MEDITERRANEAN ...Benthic Flora, Population Dynamics, Red Sea, ...5.0891

PRODUCTIVITY STUDIES IN NORTH CAROLINA SALT MARSHES ...Aerial Photography, North Carolina, Primary Productivity, Productivity - Food Chain, Swamps-marshes, Tidewater Areas, ...5.1017

CLADOPHORA AS RELATED TO POLLUTION IN WESTERN LAKE ERIE ...Algal Pollutant Sources, Bioindicators, Chemical Analysis, Cladophora, Lake Erie, ...6.0170

Migration

BIOLOGICAL RESEARCH ON THE VOLCANIC ISLAND SURTSEY AND ENVIRON ...Iceland, Volcanoes, ...5.0889

BIOTA OF THE RED SEA AND EASTERN MEDITERRANEAN ...Marine Biology (non-specific), Red Sea, Survey Studies, ...5.0691

Niches

ECOLOGY OF MARINE ENDOLITHIC ALGAE ...Algae-General, Borings - Tracks - Trails, Calcium, Habitat Studies, Textures-structures, ...5.0690

Phenology

BIOLOGY-MIDDLE EAST WATERS ...Cell Cycle, Marine Biology (non-specific), Middle-east-general, Red Sea, Reproductive System, Synchronization, ...5.0929

Physiological Ecology

IMPROVEMENT AND APPLICATION OF BENTHIC ALGAL ISOTOPE PRODUCTIVITY MEASURING METHODS ...Algae- General, Benthonic-bottom, Caulerpa, Pacific Ocean-general, Plant Prod. (non-specific), Rhodophyta (non-specific & Ot), ...5.0968

PHYSIOLOGY AND ECOLOGY OF MARINE DIATOMS ...Algae- Diatoms, Algal Culture, Habitat Studies, Marine Plants, Nutrition Studies, Plant Taxonomy, ...5.0735

ECOLOGY AND NITROGEN CYCLE IN A MARINE PLANT COMMUNITY ...Bering Sea, Nitrogen, Potamogeton, Ruppia, Zostera.., Primary Productivity, Sewage, ...5.0676

Plant Ecology (non-specific)

BIOLOGY CONFERENCE SERIES ...Ecology (animal), Marine Biology, Meetings, ...11.0035

MARINE BIOLOGY RESEARCH AT THE BERMUDA BIOLOGICAL STATION ...Bermuda, Ecology (animal), Marine Biology, Marine Biology (non-specific), ...12.0006

YEAR-ROUND PROGRAM OF RESEARCH IN MARINE ECOLOGY ...Animal Taxonomy, Aquatic Ecology, Marine Biology (non-specific), Plant Taxonomy, Training Grants, Fellowships, ...5.0899

Productivity

Plant Prod. (non-specific)

IMPROVEMENT AND APPLICATION OF BENTHIC ALGAL ISOTOPE PRODUCTIVITY MEASURING METHODS ...Algae- General, Benthonic-bottom, Caulerpa, Pacific Ocean-general, Physiological Ecology, Rhodophyta (non-specific & Ot), ...5.0968

OCEANOGRAPHIC VESSEL OPERATIONS ...Equipment Purchase Operation, Geology-general, Pacific Ocean-north, Plankton (non-specific), Ships and Cruises, ...12.0047

HOLOGRAPHIC STUDIES OF MARINE ORGANISMS ...Acoustical, Holography, Lasers-masers, Plankton (non-specific), Sampling, ...8.0060

EFFECTS OF THERMAL POLLUTION ON PRODUCTIVITY AND STABILITY OF ESTUARINE COMMUNITIES ...Aquatic Ecology, Environmental Ecology, Estuaries, Pollution - Effects of , Thermal Pollution, ...6.0152

ULTRAVIOLET ABSORPTION IN COASTAL WATERS ...Biological, Marine Plants, Physical Parameters, Sewage, Total Organic Carbon, Ultra - Violet Radiation, ...6.0138

WATERFOWL FOOD STUDIES ...Food Supply, Management, South Carolina, Waterfowl -non-specific, ...5.0653

Primary Productivity

BIOLOGICAL PRODUCTIVITY IN THE SARGASSO SEA, THE GULF STREAM AND IN THE ATLANTIC COASTAL WATERS OFF CAPE HATTERAS ...Continental Shelf, Phytoplankton, Productivity - Food Chain, Proteins, ...5.1005

C-14 UPTAKE, LIMITING FACTORS AND EXCRETION PRODUCTS OF ANTARCTIC PHYTOPLANKTON ...Antarctic Ocean, Carbon, Phytoplankton, Secretions and Products, ...5.0813

STUDIES WITH TROPICAL AND SUBTROPICAL MICROALGAE ...Algal Culture, Benthic Flora, Continental Shelf, Sub - Tropic, Tropic, ...5.0693

ORGANIC PRODUCTION OF EPIFAUNAL ORGANISMS ...Energy Budgets, Epiphytic Relationships, Marine Biology (non-specific), Organics, Plant Ecosystems(non-specific), Reefs, ...5.1032

ECOLOGICAL STUDIES OF THE SOUTHEASTERN FLORIDA SEA GRASS COMMUNITY - PRIMARY PRODUCTION BY THALASSIA TESTUDINUM KONIG ...Elodea, Waterweed, Thalassia, Florida, Submerged Plants, Translocation, Tropic, ...5.0695

STANFORD BIOLOGICAL OCEANOGRAPHY ...Marine Biology, Phytoplankton, Productivity - Food Chain, Ships and Cruises, Training Grants, Fellowships, Zooplankton, ...11.0005

NUTRIENT LIMITATION AND SOURCES OF NITROGEN FOR MARINE PRIMARY PRODUCTIO ...Marine Plants, Mathematical Biophysic, Nitrogen Fixation, Other Models, Phytoplankton, ...5.0845

BIOLOGICAL PRODUCTIVITY INVESTIGATIONS OF THE WATERS SURROUNDING ANTARCTICA ...Optical, Organics, Phytoplankton, Standing Crops, Weddell Sea, ...5.1030

PRODUCTIVITY STUDIES IN NORTH CAROLINA SALT MARSHES ...Aerial Photography, Mapping, North Carolina, Productivity - Food Chain, Swamps-marshes, Tidewater Areas, ...5.1017

BIOLOGICAL AND CHEMICAL STUDY OF VIRGINIA'S ESTUARIES ...Estuaries, Nitrogen, Phosphorus, Phytoplankton, Population Dynamics, Virginia, ...1.0158

THE ECOLOGIC IMPACT OF THE INTERACTIONS AMONG MICROORGANISMS AND AQUATIC CONTAMINANTS IN LAKE ERIE ...Lake Erie, Pollution - Effects of , Responses to Growth, Sediments, Water Bacteria, ...5.0819

EFFECTS OF RIVERS ON THE METABOLISM OF TEXAS BAYS ...Bays, Nutrients, Pollutants-general, Streams, Texas, Water Quality-general, ...6.0187

PRIMARY PRODUCTION AND DECOMPOSITION IN ESTUARINE WATER ...Estuaries, Florida, Methane Bacteria (non-specif.), Phaeophyta (non-specific & Ot), Rhodophyta (non-specific & Ot), Turnover (metabolic), ...5.0954

ECOLOGY AND NITROGEN CYCLE IN A MARINE PLANT COMMUNITY ...Bering Sea, Nitrogen, Physiological Ecology, Potamogeton, Ruppia, Zostera.., Sewage, ...5.0676

PLANKTON ECOLOGY OF BAR-BUILT ESTUARIES ...Estuaries, North Carolina, Phytoplankton, Productivity - Food Chain, Zooplankton, ...5.0816

PRIMARY PRODUCTIVITY IN PUERTO GALERA BAY, MINDORO, PHILIPPINES ...Bays, Philippines, Productivity - Food Chain, ...5.1025

ECOLOGY OF EELGRASS ...Alaska, Bering Sea, Food Webs, Phytoplankton, Potamogeton, Ruppia, Zostera.., ...5.0677

TIDE MARSH ECOLOGY AND WILDLIFE ...Management, Microorganisms (non-specific), Nitrogen Cycle, Nutrients, Phosphorus, Swamps-marshes, ...5.0870

PRODUCTIVITY OF ESTUARINE AND MARINE ECOSYSTEMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Algae- General, Estuaries, Marine Plants, Phytoplankton, Standing Crops, ...5.1010

INPEC BIOLOGICAL OCEANOGRAPHY - (PHYTOPLANKTON AND ZOOPLANKTON RESEARCH) ...Food Supply, Pacific Ocean-north, Phytoplankton, Temporal Distribution, Zooplankton, ...5.0843

PRIMARY PRODUCTIVITY ...Marine Plants, Productivity - Food Chain, Standing Crops, ...5.0955

PRODUCTIVITY MEASURES ...Number Or Density, Ocean Currents-other, Organism Sampling Devices, Pacific Ocean-east, Productivity - Food Chain, Zooplankton, ...5.0940

INTERNATIONAL WEDDELL SEA OCEANOGRAPHIC EXPEDITION ...Organics, Population Dynamics, Productivity - Food Chain, Seals, Weddell Sea, ...4.0121

Radioecology

THE ACCUMULATION OF FISSION PRODUCTS BY MARINE FISH AND SHELLFISH ...Chlorideae (non-specific & Ot), Contamination - Water, Estuaries, Food Chains, Radioactivity-general, ...6.0167

MARINE BIOLOGY PROGRAM ...Distribution, Productivity - Food Chain, Puerto Rico, Rare Earths, Trace Elements, ...1.0128

BIOLOGICAL INVESTIGATIONS WITH ISOTOPES ...Algae-General, Facilities, Isotopes -non-specific, Marine Plants, Radiation Effects-non-specific, ...11.0025

Standing Crops

BIOLOGICAL PRODUCTIVITY INVESTIGATIONS OF THE WATERS SURROUNDING ANTARCTICA ...Optical, Organics, Phytoplankton, Primary Productivity, Weddell Sea, ...5.1030

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...Aquatic Ecology, Estuaries, Mans Activities, Persistance of Residues, Pesticides -non-specific, Pollution - Effects of , Population Dynamics, ...5.0880

ANNUAL PHYTOPLANKTON PRODUCTION IN PUGET SOUND WATERS ...Copepods, Invertebrate Culture, Phytoplankton, Puget Sound, Tides, ...5.0931

PRODUCTIVITY OF ESTUARINE AND MARINE ECOSYSTEMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Algae- General, Estuaries, Marine Plants, Phytoplankton, Primary Productivity, ...5.1010

PRIMARY PRODUCTIVITY ...Marine Plants, Primary Productivity, Productivity - Food Chain, ...5.0955

STANDING STOCK AND GROWTH OF BACTERIA IN THE SEA ...Atp X Adenosine Triphosphate, Carbohydrates, Growth (non-specific & Ot.), Marine Biology, Phytoplankton, ...5.0749

Symbiosis

MARINE PHYTOPLANKTON RESEARCH ...Algal Culture, Indian Ocean-general, Nutrition Studies, Pacific Ocean-general, Phytoplankton, ...5.0847

SYMBIOSIS BETWEEN MARINE ALGAE AND INVERTEBRATES ...Gastropods -slugs,conch,snails, Photosynthetically Active, Zooxanthella, ...5.0730

SYNECOLOGY OF CARIBBEAN SPONGES ...Algae- General, Caribbean Sea, Copepods, Porifera, ...5.0580

SYMBIOSIS IN CONVOLUTA ...Algae- General, Eddyworms, ...5.0713

Economic Theory

SEARCH AND RESCUE - U.S. COAST GUARD ...Consultants, Advisory Services, Operational Aspect, Safety, ...6.0130

SYSTEM OPERATIONS AND ACOUSTIC PHYSICS ...Acoustical, Instrumentation-general, Liquids, Standards, Specifications, Systems Analysis, ...12.0020

Application

TECHNIQUES OF PLANNING ...Control Systems, Management, Mathematical Analysis, Operations Research, Planning, Southern, Systems Analysis, ...9.0017

Cost Analysis

OPTIMIZATION METHODS APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL AUXILIARY ...Algorithms, Engineering Studies-other, Optimization Technique, Other-design-and-construction, Requirement, ...8.0297

MARINE TRANSPORTATION ANALYSIS MODEL ...Input - Output Analysis, Models, Ports & Harbors, Water Vessel, ...8.0031

NUCLEAR FUEL COST ANALYSIS MODEL ...Applications, Fuel, Nuclear Power, ...4.0070

ADVANCED MARINE TRANSPORTATION SYSTEM/ANALYSIS MODEL ...Algorithms, Consumption, Input - Output Analysis, Merchant-ships, Models, Systems Analysis, ...4.0068

ANALYSIS OF THE EFFECT ON OPERATING COSTS AND RETURN ON INVESTMENT OF VARIATIONS IN OPERATING PARAMETERS ...Costs, Economics, Ocean Mining, Systems Analysis, ...4.0174

Design of Experiments

OPTIMIZATION METHOD APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL SALVAGE TUG ...Algorithms, Operational Aspect, Optimization Technique, Other-design-and-construction, Random Variables, ...8.0307

Management Science

MARINE TRANSPORTATION ECONOMIC ANALYSIS ...Economic Analysis, Freight, Production & Processing, Water Transportation, ...4.0179

Optimization Technique

SYSTEM DESIGN STUDY FOR THE U.S. NAVAL OCEANOGRAPHIC OFFICE INTELLIGENCE DATA HANDLING SYSTEM ...Data Analysis - General, Data Reduction and Analysis, Geophysics-general, Mapping, Systems Analysis, ...4.0016

Programming

HYDRODYNAMIC FLOW FIELD STUDY ...Ship Resistance Stability, Viscous, Wave, ...8.0170

Systems Analysis

ERROR ANALYSIS OF SEVERAL BOTTOM REFERENCED NAVIGATION SYSTEMS FOR SMALL SUBMERSIBLES ...Error Analysis, Navigation, Operational Aspect, Sonar, Submersibles, Subsurface Environments, ...4.0111

A SHIPBOARD DIGITAL DATA ACQUISITION SYSTEM ...Data Acquisition, Seismic Studies, Tape Storage, ...4.0036

SYSTEM DESIGN STUDY FOR THE U.S. NAVAL OCEANOGRAPHIC OFFICE INTELLIGENCE DATA HANDLING SYSTEM ...Data Analysis - General, Data Reduction and Analysis, Geophysics-general, Mapping, Optimization Technique, ...4.0016

AN ECONOMIC EVALUATION OF WATER POLLUTION CONTROL, YAQUINA BAY, ORE ...Alternative Planning, Bays, Benefit-cost Analysis, Model Studies, Oregon, Water Quality Control-general, ...6.0173

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SYSTEM OPERATIONS AND ACOUSTIC PHYSICS ...Acoustical, Economic Theory, Instrumentation-general, Liquids, Standards, Specifications, ...12.0020

ANALYSIS OF THE EFFECT ON OPERATING COSTS AND RETURN ON INVESTMENT OF VARIATIONS IN OPERATING PARAMETERS ...Cost Analysis, Costs, Economics, Ocean Mining, ...4.0174

Economics

STUDY OF OCEANOGRAPHIC MARKETS ...Consumption, Manufacturing, Oceanography-general, Trends,projections, ...4.0176

SCIENCE AND ENGINEERING GOALS FOR THE INTERNATIONAL DECADE OF OCEAN EXPLORATION ...Oceanography-general, Planning, Project Review, Science & Technology, ...4.0118

FISHING VESSEL CONSTRUCTION COSTS AND THE U.S. FISHING VESSEL CONSTRUCTION DIFFERENTIAL SUBSIDY ...Commercial Fishing, Costs, Fiscal, Other-design-and-construction, Surface Ships, ...4.0181

SECOND HAND PRICES FOR TANKERS ...Model Studies, Price & Value, Tankers, Trends,projections, ...4.0184

PRELIMINARY STUDIES OF INTERNATIONAL REGIMES FOR MARINE RESOURCES ...Legal Studies-general, Oceanography-general, Social Aspects, ...10.0001

USE OF TIDAL POWER AND OTHER OCEAN ENERGY SOURCES ...Bibliography, Engineering Studies-other, Mechanical Power-other, Survey Studies, Tides, ...2.0084

FINANCING OF FISHING VESSELS ...Commercial Fishing, Fish & Shellfish, Rhode Island, Savings and Investment, ...4.0185

ECONOMIC IMPACT OF MARINE-ORIENTED ACTIVITIES IN THE SOUTHERN NEW ENGLAND MARINE REGION ...Northeast, Regional Economic Impact, ...4.0187

WORLD WIDE MARINE MINERAL RESOURCES ...Continental Shelf, Continental Slope, Mapping, Potential of Deposit, Resource Inventories, ...4.0056

ANALYSIS OF THE EFFECT ON OPERATING COSTS AND RETURN ON INVESTMENT OF VARIATIONS IN OPERATING PARAMETERS ...Cost Analysis, Costs, Ocean Mining, Systems Analysis, ...4.0174

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MULTISPECIES FISHERIES MODELS ...California, Commercial Fishing, Model Studies, Oceanic - Pelagic, Pacific Ocean-east, Production & Processing, ...4.0065

Benefit-cost Analysis

SYSTEMS ANALYSIS ASSISTANCE TO HEADQUATERS U. S. COAST GUARD ...Model Studies, Sea Ice, Ships and Cruises, Systems Analysis, ...12.0015

STREAM IMPROVEMENT PLANNING ...Engineering Structures-general, Fish -non-specific, Management -other, Planning, Streams, ...5.0220

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SOCIO-ECONOMIC STUDY OF NARRAGANSETT BAY, RHODE ISLAND ...Bays, Estuaries, Land Use, Rhode Island, Social Aspects, Water Quality Control-general, ...9.0019

Commodities

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RADIATION PRESERVATION OF FISHERY PRODUCTS ...Commercial Fishing, Fish -non-specific, Organoleptic Studies, Radiation, Shelf Life & Storage, ...6.0034

SYSTEMS ENGINEERING AND DEVELOPMENT OF COMMERCIALLY VALUABLE MARINE RESOURCES IN THE DELAWARE AREA ...Aquaculture & Fish-farming, Commercial Fishing, Delaware, Oysters, Quality -non-specific, ...8.0002

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CONSUMER EVALUATION OF FISH PRODUCTS ...Consumer Pref. & Consumption, Fish -non-specific, Organoleptic Studies, Smoking, ...6.0004

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INSTITUTIONAL ARRANGEMENTS FOR THE MARINE SCIENCES ...International Affairs, Management, Management and Administration, Oceanography-general, ...10.0005

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ANALYSIS OF THE DEMAND FOR RED MEAT, POULTRY, EGGS, SEAFOOD, AND MEAT MIXTURES ...Consumer Pref. & Consumption, Eggs, Fish -non-specific, Meat -non-specific, ...6.0019

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ISLAND STUDY ...Conservation-general, Islands, Recreation Sites, Types of Resources, United States-general, ...9.0005

Optimization

GALVESTON BAY STUDY ...Estuaries, Numerical Analysis-other, Simulation, Tides, Waste Water Treatment-general, ...4.0062

Regional Economic Impact

DETERMINATION OF THE STRUCTURE & ECONOMIC IMPORTANCE OF THE VARIOUS SEGMENTS OF THE SEAFOOD INDUSTRY ...Commercial Fishing, Consumer Pref. & Consumption, Fish & Shellfish, Fish -non-specific, Georgia, Production & Processing, Shellfish -non-specific, ...4.0180

ECONOMIC IMPACT OF MARINE-ORIENTED ACTIVITIES IN THE SOUTHERN NEW ENGLAND MARINE REGION ...Economics, Northeast, ...4.0187

Types

Manufacturing

STUDY OF OCEANOGRAPHIC MARKETS ...Consumption, Economics, Oceanography-general, Trends,projections, ...4.0176

Processing

APPLICATION OF RADIATION PASTEURIZATION PROCESSES TO PACIFIC CRAB AND FLOUNDER ...Clostridium Botulinum, Fish -non-specific, Microbiological, Radiation, Toxicological and Allergy, ...6.0083

DEVELOPMENT OF NEW HUMAN FOOD PRODUCTS FROM SHAD ...Fish & Shellfish, Sausage and Variety Meats, Shad, Shelf Life & Storage, Smoking, ...6.0065

EFFECT OF PROCESS ON SHELLFISH ...Clams, Processed Product Quality, Sanitation, Shelf Life & Storage, Winter, ...6.0059

ESTIMATING THE VALUE ADDED TO SEAFOOD PRODUCTS LANDED IN GEORGIA AT THE VARIOUS STAGES OF THE MARKETING CHANNEL ...Fish -non-specific, Georgia, Quality -non-specific, Shellfish -non-specific, ...6.0020

ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST ...Commercial Fishing, Fish & Shellfish, Market Structure, Maryland, Northeast, ...4.0182

MARKETING EFFICIENCY IN A COOPERATIVE FOOD-FISH PROCESSING PLANT, A CASE STUDY ...Design, Machinery, Equipment, Fish & Shellfish, Fish -non-specific, Freezing, Shelf Life & Storage, ...6.0079

CONTAINERIZATION OF FISHERY PRODUCTS ...Commercial Fishing, Fish -other, Packaging, Shrimp, ...6.0049

Retail

MARKET RESEARCH STUDIES ON THE EFFECTS OF THE FLORIDA MARKETING PROGRAM ON THE SALE OF FLORIDA SEAFOODS ...Fish -non-specific, Florida, Institutional Management, Marketing, ...6.0018

Water Costs

BRACKISH WATER PURIFICATION BY BIOLOGICAL FUEL CELL POWERED ELECTRODIALYSIS ...Biological, Brackish Water, Desalination, Desalination Wastes, Electrodialysis, Material Recovery Wastes, ...6.0161

Welfare Economics

USE OF THE COASTAL ZONE FOR THE U. S. COASTLINE OF LAKE ERIE AND LAKE SUPERIOR ...Lake Erie, Lake Superior, Lakeshores-inlets, Land Use, Social Aspects, ...9.0004

EFFECTS OF WATER POLLUTION IN SAN FRANCISCO BAY ...Bays, Economic Impact, Pollution - Effects of , Recreation Sites, San Francisco Bay, Social Aspects, Water Utilization - domestic, ...6.0140

Eddyworms

SYMBIOSIS IN CONVOLUTA ...Algae- General, Symbiosis, ...5.0713

Electric Lighting Systems

FEASIBILITY STUDY FOR A GATED-LASER, IMAGE-AMPLIFIER UNDERWATER VISION SYSTEM ...Image Converters, Lasers-masers, Optical Devices, Photography, Technique Development, ...8.0108

VISUAL LANDING AIDS FIELD ...Atmosphere Optical Phenomena, Detectors, Fog-haze-mist, Infrared Radiation, Lighting, ...4.0086

Electric Power Generation

Batteries

CONSULTATIVE AND ADVISORY SERVICES - BATTERY PROBLEMS ...Consultants, Advisory Services, Instrumental Services, Standards, Specifications, ...11.0021

Thermoelectric

INVESTIGATION OF NUCLEAR THERMIONIC POWER FOR MARINE APPLICATIONS ...Electron Emission, Marine Environments-general, Nuclear Power, Power Conversion Systems, ...8.0155

THERMO-ELECTRIC GENERATORS ...Buoys, Generators, ...8.0162

Electric Power Transmission

Power Transmission Systems

POWER SOURCES ...Benthonic-bottom, Safety, Submerged Ships, Technique Development, Underwater-construction, ...8.0156

Electro-osmosis

ELECTROKINETIC SOIL STUDY ...Buried Structures, Electroosmosis, Electrophoresis, Laboratory Analysis, Marine Soils, Stabilization, ...8.0342

Electroanalyses

Conductrometry

AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE - LABORATORY PROCEDURES ...Colorimetry, Computer Applications, Management, Nitrogen, Phosphate, Phosphite, Swamps-marshes, ...5.0761

Electrochemistry

Electrodialysis

BRACKISH WATER PURIFICATION BY BIOLOGICAL FUEL CELL POWERED ELECTRODIALYSIS ...Biological, Brackish Water, Desalination, Desalination Wastes, Material Recovery Wastes, Water Costs, ...6.0161

Electromechanical Design

A DESIGN PROGRAM FOR SUPERCONDUCTING ELECTRICAL MACHINES ...Electrical, Instrumental Services, Marine Propulsion, Superconductive Device, ...8.0132

Electron Emission

INVESTIGATION OF NUCLEAR THERMIONIC POWER FOR MARINE APPLICATIONS ...Marine Environments-general, Nuclear Power, Power Conversion Systems, Thermoelectric, ...8.0155

Electronic Components

Cables and Transmission Lines

SUBMARINE SEISMIC PROFILES OF THE WORLDS OCEANS ...Atlantic Ocean-general, Data Analysis - General, Indian Ocean-general, Seismic Studies, Subbottom, ...7.0150

LOW NOISE MULTI-CHANNEL HYDROPHONE CABLE ...Amplifiers, Bathymetry, Seismic Studies, Telephone, Transmission Lines, ...8.0145

COLLECTION, ANALYSIS, INTERPRETATION, AND PRESENTATION OF OCEANOGRAPHIC - GEOLOGIC DATA IN CONNECTION WITH SUBMARINE CABLE SYSTEM DEVELOPMENT ...Data Acquisition, Data Analysis - General, Submerged Ships, Transmission Lines, ...7.0043

Electronic Components-other

INSTRUMENT STUDIES ...Evaluation Other, Instrumental Services, Testing Facilities, ...8.0104

Electronic Tubes

Image Converters

FEASIBILITY STUDY FOR A GATED-LASER, IMAGE-AMPLIFIER UNDERWATER VISION SYSTEM ...Electric Lighting Systems, Lasers-masers, Optical Devices, Photography, Technique Development, ...8.0108

X Ray Tubes

X-RADIOGRAPHIC AND ELECTRONIC FLUOROSCOPIC EQUIPMENT ...Core Analysis, Equipment Purchase Operation, Instrumental Services, Radiograph, Radiometer, ...8.0094

Electronic-flash-lights

PSYCHOPHYSICAL EFFECTS OF XENON FLASHTUBES ...Navigation Communication, Optical Sources, Lamps, Visible, Xenon, ...8.0053

Electronic Components

Transducers

NAVIGATION RECEIVER ...Navigation, Navigation Systems-other, Radio, Sonar, Transponders, ...4.0112

EXPERIMENTAL HIGH RESOLUTION SUB-BOTTOM PROFILING SYSTEM ...Amplifiers, Receivers, Sonar, Sonar and Echo Sounding, Subbottom, ...8.0109

PRESSURE INSENSITIVE VELOCIMETER ...Acoustical, Instrumental Services, Pressure, Velocimeter, Velocity, ...8.0055

TURBULENCE STRUCTURE AND NOISE STUDY ...Additives, Noise, Turbulent, ...1.0002

PRECISION QUARTZ CAPACITANCE PRESSURE TRANSDUCERS ...Capacitance, Pressure, Quartz, Technique Development, ...8.0121

ADVANCE SONAR SYSTEMS ...Data Display, Instrumental Services, Sonar, Sonar and Echo Sounding, Testing Facilities, ...8.0096

TRANSDUCER RESEARCH ...Packaging, Sealant, Submersibles, ...8.0095

NEW SEA GRAVITY METER ...Capacitance, Geophysical Equipment, Gravimetric, Gravity Studies, Instrumental Services, ...8.0067

THEORETICAL AND LABORATORY MODEL STUDIES OF LARGE-SCALE OCEAN CIRCULATION ...Circulation-general, Currents-ocean, Forecasting-prediction, Gulf Stream, Model Studies, ...2.0023

ARCTIC SEISMIC TRANSDUCER EVALUATION ...Applied Electronics, Arctic, Evaluation Other, Ice Acoustics, Propagation, ...8.0118

DEEP SUBMERGENCE DISSOLVED OXYGEN TRANSDUCER ...Gases, Instrumental Services, Oxygen, Submersibles, ...8.0057

HUMIDITY SENSORS ...Barium, Fluoride, Humidity Instruments, Stability, ...8.0083

AUTOMATED FLOW SYSTEM CALIBRATION ...Aircraft, Controls, Digital Computer Applications, Fluids, ...8.0071

ENVIRONMENTAL TEST AND EVALUATION ...Acoustic, Testing Facilities, Ultrasonic Technology, ...8.0128

COAST GUARDS COASTAL OCEANOGRAPHIC MONITORNG NETWORK ...Automatic Stations, Buoys, Instrumental Services, Recording Systems, Telemetry-other, ...4.0006

Electronics

Electric Circuits and Networks

TESTING AND EVALUATION OF HIGH-RESOLUTION ACOUSTIC SUBBOTTOM PROFILER THROUGH MODIFICATION OF OFF-THE-SHELF COMPONENTS ...Distribution, Evaluation Other, Field Testing, Sonar, ...8.0115

Microwave Techniques

MICROWAVE RADIOMETER DEVELOPMENT ...Instrumental Services, Microwave Radiation, Radiation Detection, Radiation-terrestrial, Wave Form, ...8.0056

AEROLOGICAL INSTRUMENTS ...Amplifiers, Field Testing, Humidity Instruments, Instrumental Services, Technique Development, ...8.0082

Signal Analysis

Doppler

INTEGRATION OF DOPPLER SATELLITE AND LORAC NAVIGATIONAL SERVICES ...Loran, Navigation, Satellites, ...4.0110

Interference

STUDY OF PROBABILITY OF DETECTION AND FALSE ALARM RATE OF FREQUENCY ACOUSTIC TELEMETERING SYSTEM ...Acoustical, Oil and Natural Gas - Sulfur, ...8.0106

AUDITORY DETECTION ...Fog-haze-mist, Spectral Distribution, Spectrum, Wave Analyzer, ...4.0095

Noise

TURBULENCE STRUCTURE AND NOISE STUDY ...Additives, Turbulent, ...1.0002

AMBIENT SEA NOISE INVESTIGATION ...Acoustic, Acoustical, Computer Applications, Waves, Wind-water Interaction, ...1.0048

ARCTIC ACOUSTIC RESEARCH ...Applied Electronics, Arctic, Ice Acoustics, Transmission, ...1.0001

Signal Analysis-other

SOUND TRANSMISSION IN THE SEA ...Acoustical, Sonar, Transmission, ...1.0020

UNDERWATER ACOUSTIC ANALYSIS ...Acoustical, Forecasting-prediction, Phase Relationships, Transmission, Water Properties-general, ...1.0038

SIGNAL COHERENCE AND ARRAY DESIGN STUDIES ...Acoustical, Coherence, Reflection, Spectra, Waveform, ...1.0024

Spectrum

MOVABLE OCEAN MEASUREMENT SYSTEM ...Acoustical, Instrumental Services, Platforms, Spectral Distribution, ...8.0117

AUDITORY DETECTION ...Fog-haze-mist, Interference, Spectral Distribution, Wave Analyzer, ...4.0095

Transient

DEVELOPMENT OF ANALYSIS TECHNIQUES FOR CLASSIFYING TRANSIENT HYDROACOUSTIC SIGNALS ...Acoustical, Acoustics, Seismic Studies, Signal Detection, ...1.0068

Wave Analyzer

AUDITORY DETECTION ...Fog-haze-mist, Interference, Spectral Distribution, Spectrum, ...4.0095

Waveform

SIGNAL COHERENCE AND ARRAY DESIGN STUDIES ...Acoustical, Coherence, Reflection, Signal Analysis-other, Spectra, ...1.0024

SUBMERGED OPERATIONS COMMUNICATIONS (SUBCOM) ...Converters - Coders, Diving and Scuba, ...8.0023

Solid State

Amplifiers

EXPERIMENTAL HIGH RESOLUTION SUB-BOTTOM PROFILING SYSTEM ...Receivers, Sonar, Sonar and Echo Sounding, Subbottom, Transducers, ...8.0109

LOW NOISE MULTI-CHANNEL HYDROPHONE CABLE ...Bathymetry, Cables and Transmission Lines, Seismic Studies, Telephone, Transmission Lines, ...8.0145

AEROLOGICAL INSTRUMENTS ...Field Testing, Humidity Instruments, Instrumental Services, Microwave Techniques, Technique Development, ...8.0082

FREQUENCY TIME RESEARCH ENGINEERING ...Electromagnetic Transmission, Frequencies-other, Frequency Conversion, Time Measurements, Very Low Frequency, ...8.0068

Detectors

VISUAL LANDING AIDS FIELD ...Atmosphere Optical Phenomena, Electric Lighting Systems, Fog-haze-mist, Infrared Radiation, Lighting, ...4.0086

Signal Generators

WWV BROADCASTS ...Navigation, ...4.0089

SATELLITE TIME DISSEMINATION ...Airborne Probing, Communication & Navigation, Doppler, Navigation, Standards, Specifications, Time Measurements, ...4.0091

WWVB-WWVL BROADCASTS ...Frequency Standards, Low Frequency, Navigation, Radio, Standards, Specifications, Time Measurements, Very Low Frequency, ...4.0090

Superconductive Device

A DESIGN PROGRAM FOR SUPERCONDUCTING ELECTRICAL MACHINES ...Electrical, Electromechanical Design, Instrumental Services, Marine Propulsion, ...8.0132

Transmission Lines

LOW NOISE MULTI-CHANNEL HYDROPHONE CABLE ...Amplifiers, Bathymetry, Cables and Transmission Lines, Seismic Studies, Telephone, ...8.0145

COLLECTION, ANALYSIS, INTERPRETATION, AND PRESENTATION OF OCEANOGRAPHIC - GEOLOGIC DATA IN CONNECTION WITH SUBMARINE CABLE SYSTEM DEVELOPMENT ...Cables and Transmission Lines, Data Acquisition, Data Analysis - General, Submerged Ships, ...7.0043

Ultrasonic Technology

ENVIRONMENTAL TEST AND EVALUATION ...Acoustic, Testing Facilities, Transducers, ...8.0128

Electrophoresis

Disc Electrophoresis

ELECTROPHORETIC PROFILES FOR THE IDENTIFICATION OF FISH SPECIES ...Fish -non-specific, Gel Electrophoresis, Infection, Intoxication & Pois, Legal Standards, ...6.0014

Electrophoresis -non-specific

STOCK IDENTIFICATION OF ATLANTIC TUNAS ...Atlantic Ocean-general, Caribbean Sea, Tuna, Mackerel, Albacore... , ...5.0252

Gel Electrophoresis

COMPARATIVE BIOCHEMISTRY OF PROTEINS FROM GULF FISH ...Blood Proteins -non-specific, Drums, Hemoglobin, Shrimps - Common, ...5.0326

ELECTROPHORETIC PROFILES FOR THE IDENTIFICATION OF FISH SPECIES ...Disc Electrophoresis, Fish -non-specific, Infection, Intoxication & Pois, Legal Standards, ...6.0014

Elementary Particles

Magnetic Monopole

SEARCH FOR FERROMAGNETICALLY TRAPPED MAGNETIC MONOPOLES OF COSMIC RAY ORIGIN ...Field Reversals, Magnetic Studies, Paleomagnetism, Physical Properties, ...7.0114

Encapsulation

HYDROGEN-OXYGEN FUEL CELLS ...Fuel Cell-other, Gas Generator, Oxidants, Safety, Submersibles, ...8.0160

Endogenous Biological Extracts

CONTROL OF PLANT PATHOGENS USING ACTIVE ANTIMICROBIAL SUBSTANCES ISOLATED FROM MARINE ALGAE ...Bacteria , Fungi -non-specific, Growth Substances, Marine Plants, Nutrition in Disease, ...6.0127

Energy

OCEANOGRAPHY, PLEISTOCENE GEOLOGY AND SEDIMENTS OF LITTLE BAHAMA BANK ...British West Indies, Carbonates-general, Currents-bottom, Quaternary Period, Water Motion Recorders, ...7.0229

STUDY OF OCEANIC TURBULENCE ...Hydrodynamics, Mixing, Subsurface Environments, Turbulence - Sea Water, Water Motion, ...2.0055

BIOCHEMICAL AND BIOPHYSICAL STUDIES OF THE MARINE ENVIRONMENT ...Copepods, Energy Budgets, Organics, Productivity - Food Chain, ...5.0767

OCEAN CURRENTS AND CIRCULATION ...Circulation-general, Currents-ocean, Data Acquisition, Model Studies, Temperature, ...2.0015

GREAT LAKES RESEARCH - COASTAL AREA SEDIMENTATION ...Beach, Development, General Transport Effects, Great Lakes-general, Model Studies, Sedimentation, ...7.0124

Engineering Geology

PRELIMINARY STUDIES TO CORRELATE SELECTED MINERALOGIC AND GEOLOGIC PROPERTIES WITH ENGINEERING PROPERTIES ...Alaska, Mineralogy, Petrology, Ships and Cruises, Trace Element Analysis, ...8.0169

Engineering Mechanics

Analysis

VISCO-ELASTIC DYNAMIC VIBRATION ABSORBER ...Close Channel, Drag, Energy Dissipators, Hydraulic Equipment, Vibrating Systems-other, Viscous, ...8.0188

Forces and Loading

Random

AN INVESTIGATION OF THE S/N FATIGUE LIFE GAGE ...Stress Recorders, ...8.0100

Static

DETERMINATION OF FLOW IN AN AXIAL-TO-RADIAL DIFFUSER WITH SWIRL ...Configuration of Body, Impinging Jets, Model Apparatus-other, Pressure Gradient, Rotors-propellers, ...8.0187

Mechanical Vibrations

Non-linear

INVESTIGATION OF THE NON-LINEAR CHARACTERISTICS OF FLUID-SUSPENDED VEHICLES ...Dimensionless-parameters-other, Hydrofoils Crafts, Non Linear, Simulation Theory, Stability, ...8.0184

Response

AN ANALYSIS OF THE RESPONSE OF CYLINDRICAL DUCTS TO INTERNAL, ZERO MEAN FLOW, AIR-CARRIED ACOUSTIC EXCITATION ...Acoustic Field, Close Channel, Geometric Configuration, ...8.0181

Vibrating Systems-other

VISCO-ELASTIC DYNAMIC VIBRATION ABSORBER ...Analysis, Close Channel, Drag, Energy Dissipators, Hydraulic Equipment, Viscous, ...8.0188

Moments

STRESSES DEVELOPED ON THE SURFACE OF CYLINDRICAL JOINTS SUBJECTED TO MULTIPLE LOADS ...Analysis Structural, Geometric Configuration, Joints, Stress Concentration, Stresses, ...8.0304

Stability

INVESTIGATION OF THE NON-LINEAR CHARACTERISTICS OF FLUID-SUSPENDED VEHICLES ...Dimensionless-parameters-other, Hydrofoils Crafts, Non Linear, Non-linear, Simulation Theory, ...8.0184

WAVE ACTION ON STRUCTURES ...Engineering Structures-general, Hydrodynamic Structures, Models, Shoreline Structures, Wave Action, Waves, ...8.0175

Strength

A STUDY OF THE INTERFACE LOCATIONS BETWEEN DISSIMILAR MATERIALS AND OTHER ASPECTS OF A COMPOSITE MIDSHIP SECTION ...Bulkheads, Hull, Hydrodynamic Structures, ...8.0294

Stress Concentration

STRESSES DEVELOPED ON THE SURFACE OF CYLINDRICAL JOINTS SUBJECTED TO MULTIPLE LOADS ...Analysis Structural, Geometric Configuration, Joints, Moments, Stresses, ...8.0304

Stresses

STRESSES DEVELOPED ON THE SURFACE OF CYLINDRICAL JOINTS SUBJECTED TO MULTIPLE LOADS ...Analysis Structural, Geometric Configuration, Joints, Moments, Stress Concentration, ...8.0304

Engineering Structures-general

STREAM IMPROVEMENT PLANNING ...Benefit-cost Analysis, Fish -non-specific, Management -other, Planning, Streams, ...5.0220

EFFECTS OF MARSH MANAGEMENT STRUCTURES UPON FISHES ...Alewife,menhaden,shad,herring, Crabs, Land Use, Shrimps - Common, Spawning & Nesting Sites, Swamps-marshes, ...5.0206

STABILITY OF RUBBLE-MOUND BREAKWATERS ...Breakwaters, Design Criteria, Hydrodynamics, Shoreline Structures, Wave Action, Waves, ...8.0045

WAVE ACTION ON STRUCTURES ...Hydrodynamic Structures, Models, Shoreline Structures, Stability, Wave Action, Waves, ...8.0175

CORRELATION OF BEACH PROPERTIES AND INCIDENT WAVES ...Beach, Development, General Transport Effects, Sea Level Variations, Shoreline Structures, Waves, ...8.0204

ADULT SALMON BEHAVIOR STUDIES IN RIVERS AND AT DAMS (SONIC TRACKING) ...Behavioral Ecology, Salmon & Trout - Non-specific, Streams, Tags, Telemetry, ...8.0111

COLLECTION OF JUVENILE MIGRANTS FROM RIVERS AND STREAMS ...Electric Power Plants, Fish -non-specific, Management -other, Migration, Streams, ...5.0513

Engineering Structures-general

RELATION OF RIVER-RUN IMPOUNDMENTS TO SALMON PRODUCTION ...Aquatic Ecology, Environmental Changes, Environmental Ecology, Mans Activities, Pollution - Effects of , Salmon & Trout - Non-specific, ...5.0222

SALMON PRODUCTION IN AREAS MADE INACCESSIBLE BY DAMS ...Aquatic Ecology, Columbia River, Environmental Ecology, Salmon & Trout - Non-specific, Spawning & Nesting Sites, ...5.0224

FISH BEHAVIOR AND PHYSIOLOGY ...Behavior, Environmental Physiology, Migration, Salmon & Trout - Non-specific, Thermal Pollution, ...5.0331

FISHWAY RESEARCH (BONNEVILLE LABORATORY) ...Behavioral Ecology, Environmental Ecology, Management - other, Migration, Salmon & Trout - Non-specific, ...8.0016

PROTECTION OF FINGERLING SALMON IN TURBINES ...Construction Land Use Effects, Migration, Mortality Rates, Salmon & Trout - Non-specific, Snake River, ...8.0014

EVALUATION OF ENGINEERING PROJECTS AND ESTUARINE DATA (ESTUARINE PROGRAM) ...Commercial Fishing, Estuaries, Gulf of Mexico, Habitat Studies, Swamps-marshes, ...9.0021

Engineering Studies-general

PASSIVE BUOYANCY SYSTEMS ...Buoyant, Flotational, Foam, Porous, Materials Used Undersea, Other-design-and-construction, Submersibles, ...8.0263

APPLIED MARINE ENGINEERING PROGRAM AT SCRIPPS INSTITUTION OF OCEANOGRAPHY ...California, Harbors, Marine Biology, Marine Biology (non-specific), Other-design-and-construction, Scientific-service-support, Teaching and Research, Training Grants, Fellowships, ...11.0006

SYMPOSIUM ON THE MINERAL RESOURCES OF THE WORLD OCEAN ...Meetings, Ocean Mining, Policy Making, Rhode Island, ...7.0027

OCEAN ENGINEERING RESEARCH ...Alloys, Materials Used Undersea, Moorings, Water, Water Properties-general, ...8.0050

HANDBOOK OF MARINE TECHNOLOGY ...General Sea Water Chemistry, Geology-general, Handbooks, Marine Biology, Meteorological Studies, Submersibles, ...11.0014

OCEAN ENGINEERING STUDIES ...Applied Electronics, Data Acquisition, Data Processing Services, Instrumental Services, Laboratory Analysis, Sonar, ...8.0052

DEEP OCEAN RESEARCH AND DEEP OCEAN ENGINEERING ...Abyssal, Geophysics-general, Marine Biology, Structural Studies, Submersibles, Textures-structures, ...4.0131

WOODS HOLE STUDY ACTIVITIES ...Acoustical, Consultants, Advisory Services, General Information Services, ...11.0031

THERMALLY SUSTAINED PRESSURE OSCILLATIONS IN LIQUID HELIUM APPARATUS ...Boiling & Evaporation, Boundary-layer-other, Conduction, Heat-transfer-other, Model Apparatus-other, Pressure Gradient, ...8.0024

CONTROL OF SUPERCONDUCTING MACHINES FOR SHIP PROPULSION ...Marine Propulsion, Mathematical Analysis, Model Studies, Operational Aspect, ...8.0301

ADVANCED DEEP OCEAN TECHNOLOGY ...Life-support-system, Marine Propulsion, Submersibles, ...8.0282

Engineering Studies-other

STABLE OCEANIC STATION ...Floating Structure Stability, Platforms, Underwater-construction, ...8.0287

OCEANOGRAPHIC DATA SYSTEMS ...Acoustical, Data & Statistics Storage, Hydrodynamics, Instrumentation-general, Pollution Sources-general, ...4.0013

OCEANOGRAPHIC ENGINEERING ...Bathythermographs, Experiments and Tests, Other-design-and-construction, Platforms, Special Mission Ships, ...8.0269

EFFECTS OF DEEP SEA SEDIMENTS ON SUDDEN IMPACT, AS FROM DISASTER VEHICLES ...Coring and Dredging, Marine Soils, Mechanical Properties, Physical Properties, Shear Strength, ...7.0228

CIVIL ENGINEERING STRUCTURES IN THE OCEANS ...Coastal Engineering-other, Foundations-general, Model Studies, Soil Dynamics, Waves, ...8.0340

INVESTIGATION OF NAVAL SHIP FORMS ...Bulkheads, Military Aspects, ...8.0300

AN INVESTIGATION OF THE PERFORMANCE OF A COLUMN STABILIZED PLATFORM ...Experiments and Tests, Models, Platforms, Ship Resistance Stability, ...8.0296

OPTIMIZATION METHODS APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL AUXILIARY ...Algorithms, Cost Analysis, Optimization Technique, Other-design-and-construction, Requirement, ...8.0297

EFFECTS OF MATERIAL VARIATIONS IN THE COMPUTERIZED DESIGN OF PRIMARY HULL STRUCTURE ...Bulkheads, Computer Applications, Low Alloy Steels, Materials Used Undersea, Strength, Cohesion, ...8.0298

AN OPTIMUM LOADING SEQUENCE FOR CONTAINERSHIPS ...Computer Applications, Freight, Loading/unloading, Model Studies, Packing, ...8.0033

ESTIMATION OF HULL STEEL WEIGHTS FROM MIDSHIP SECTION CHARACTERISTICS ...Bulkheads, Measuring Devices-other, Naval Architecture-general, ...8.0303

USE OF TIDAL POWER AND OTHER OCEAN ENERGY SOURCES ...Bibliography, Economics, Mechanical Power-other, Survey Studies, Tides, ...2.0084

ANALYSIS OF AN ATTEMPT TO CONTROL BEACH EROSION AT SCIENTISTS CLIFFS, MARYLAND ...Beaches, Chesapeake Bay, Erosion, Groin, Maryland, ...8.0038

SWIMMER HIGH DEFINITION SONAR ...Diving and Scuba, Diving-system, Maintenance-system, Sonar, Underwater-construction, ...8.0019

CONSTRUCTION SYSTEMS ...Benthonic-bottom, Equipment, Submerged Ships, Underwater-construction, ...8.0120

STUDY OF EFFECTS OF OFFSHORE DUMPING ...Circulation-general, Dispersion -water, Pollution - Effects of , Pollution Sources-other, Shoreline - Coastline, ...6.0144

Entomology

Cultural Control of Insects

THE EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ON BEEF CATTLE PRODUCTION, PLANT ECOLOGY, SOIL PRODUCTIVITY, AND ESTUARINE ANIMALS ...Ectoparasitic Insects, Management, Wetlands, ...5.0927

Growth, Moulting & Metamorph

REVISION OF GENERA AND SUBGENERA OF WATER MITES OF THE WORLD ...Animal Taxonomy, Nomenclature, Classification, Pubilications -other, Ticks & Mites, World Wide, ...5.0627

Locomotion

NEUROPHYSIOLOGICAL MECHANISMS IN BEHAVIOR ...Giant Water Bug, Water Strider, Horseshoe Or King Crabs, Proprioceptors, ...5.0490

Musculoskeletal System

CONDUCTION AND INTEGRATION ...Behavior, Cellular Physiology, Hydra, Portuguese Man-of-war, Katydids, Nervous System, ...5.1018

Nutrition and Metabolism

ULTRASTRUCTURE OF CELL ION TRANSPORT MECHANISMS ...Active Transport, Electron Microscopy, Mitochondrial Membranes, Osmoregulation, Respiratory System, ...5.0974

Tumors

THE DISEASES OF INVERTEBRATE ANIMALS ...Developmental Physiology, Immumology, Invertebrate Pathology, ...5.0536

Veterinary Entomology

Ectoparasitic Insects

THE EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ON BEEF CATTLE PRODUCTION, PLANT ECOLOGY, SOIL PRODUCTIVITY, AND ESTUARINE ANIMALS ...Cultural Control of Insects, Management, Wetlands, ...5.0927

Environmental Changes

PALEONTOLOGICAL EVIDENCE OF CYCLES IN THE EARTH-MOON SYSTEM ...Comparative Studies-other, Invertebrates, Origins, Shells, Thin Sections, Tides, ...7.0167

REGIONAL COASTAL CHANGE ...Development, Quaternary Period, Shoreline - Coastline, ...7.0301

CHEMICAL RESPONSES BY MARINE ORGANISMS TO STRESS ...Environmental Ecology, Environmental Physiology, Protein, Salinity, Thermal, ...5.1026

ENVIRONMENTAL CHANGES IN LAKE ERIE ...Aquatic Ecology, Environmental Ecology, Ions and Gases, Lake Erie, Nutrients, ...5.0903

PILOT STUDY OF LIMITED PORTION OF TRADE WIND ZONE OCEANOGRAPHY (DATA AND DESCRIPTIVE REPORTS) ...Oceanic Fronts, Pacific Ocean-north, Technique Development, Water Properties-general, ...4.0129

ANALYZE AND PUBLISH BASIC DATA FROM PILOT STUDY ...Oceanic Fronts, Pacific Ocean-general, Salinity, Technique Development, Thermal, ...4.0024

RELATION OF RIVER-RUN IMPOUNDMENTS TO SALMON PRODUCTION ...Aquatic Ecology, Engineering Structures-general, Environmental Ecology, Mans Activities, Pollution - Effects of , Salmon & Trout - Non-specific, ...5.0222

CIRCULATION DYNAMICS (GULF OCEANOGRAPHY PROGRAM) ...Circulation-general, Gulf of Mexico, Shrimps - Common, Thermodynamics, ...2.0045

Environmental Effects-geologic

HAWAIIAN OCEANOGRAPHY ...Circulation-general , Hawaii, Hydrodynamics, Islands, Ocean Currents-other, ...2.0021

THE PORIFERA OF FANNING ISLAND, CENTRAL PACIFIC ...Animal Taxonomy, Dispersion -other, Line Islands, Porifera, ...5.0539

ECOLOGY AND SEDIMENTARY PATTERNS OF FORAMINIFERA ...Chemistry, Environmental Ecology, Foraminifera, Vertical Distribution, ...5.0746

THE SEDIMENTARY AND DIAGENETIC RECORD OF ENVIRONMENTAL PARAMETERS IN RECENT BAHAMIAN TIDAL FLATS ...British West Indies, Diagenesis, Intertidal Areas, Local Stratigraphy, Paleoclimatology, ...7.0163

THEORETICAL STUDIES OF TSUNAMI PROPAGATION ...Depth, Forecasting-prediction, Geomorphology-topography, Tsunami, Waves, ...2.0122

ARCTIC FIELD RESEARCH ...Arctic Ocean, Bibliography, Geophysics-general, Russia, ...11.0011

UTILIZATION OF PHYSICAL AND MATHEMATICAL MODELS IN MARINE WATER RESOURCES RESEARCH AND MANAGEMENT ...Estuaries, Management, Mathematical Analysis, Model Studies, Shoreline - Coastline, ...4.0084

OCEANOGRAPHIC RESEARCH-INVESTIGATIONS IN SHALLOW WATER ...Acoustical, Model Studies, Salinity, Thermal, Water Motion, ...1.0009

SHALLOW WATER OCEANOGRAPHY (SEALAB III) ...Diving and Scuba, Diving-system, Instrumentation-general, Underwater-laboratory, ...1.0146

ARCTIC UNDERSEAS RESEARCH, PHYSICAL AND CHEMICAL PROPERTIES OF SEA ICE ...Arctic Ocean, Ice Properties-general, Model Studies, Sea Ice, ...3.0070

SHALLOW WATER OCEANOGRAPHY ...Continental Shelf, Forecasting-prediction, Pressure, Subsurface Environments, Waves, ...1.0172

PREDICTIVE OCEAN ACOUSTICS ...Acoustical, Forecasting-prediction, Transmission, Velocity, ...1.0034

DESIGN AND CONSTRUCTION ...Coatings-general, Hydrodynamic Structures, Safety, Underwater-construction, Water, ...8.0333

LABORATORY STUDIES TO DETERMINE ROCK PROPERTIES UNDER HYDROSTATIC (SEA WATER) PRESSURE ...Marine Environments-general, Physical Properties, Rock Mechanics, Survey Studies, ...8.0330

HISTORICAL STUDY ON EFFECT OF HARBOR DREDGING ON THE ENVIRONMENT (ENVIRONMENTAL FACTORS PERTINENT TO EFFECTS ON MARINE ENVIRONMENTS) ...Dredging, Excavation, Harbors, Marine Environments-general, Ocean Mining, ...6.0135

THE EFFECTS OF ENVIRONMENTAL CONDITIONS ON THE SPAWNING AND SURVIVAL OF FRY OF THE WALLEYE ...Eutrophication, Lake Erie, Pollution - Effects of , Temperature, Walleyes, ...5.0299

SURVEY, EVALUATION & SUMMARIZATION OF LITERATURE ON ENVIRONMENTAL REQUIREMENTS OF MARINE ORGANISMS LEVELS OF POTENTIAL TOXICANTS (ABBREV ...Biology, Chemical, Geosciences, Library, Marine Biology, Marine Environments-general, Survey Studies, ...4.0037

Environmental Factors-geologic

Chemical

SURVEY, EVALUATION & SUMMARIZATION OF LITERATURE ON ENVIRONMENTAL REQUIREMENTS OF MARINE ORGANISMS LEVELS OF POTENTIAL TOXICANTS (ABBREV ...Biology , Environmental Effects-geologic, Geosciences, Library, Marine Biology, Marine Environments-general, Survey Studies, ...4.0037

Physical

PHYSICAL GEOGRAPHY OF TROPICAL COASTAL LOWLANDS ...Development, Geography-physical, Physical Features-general, Shore Features-general, Tropic, ...7.0298

Geomorphology

ISLAND-CURRENT INTERACTIONS ...Acoustical, Currents-ocean, Data Analysis - General, Islands, Model Studies, ...2.0116

Tides

PALEONTOLOGICAL EVIDENCE OF CYCLES IN THE EARTH-MOON SYSTEM ...Comparative Studies-other, Environmental Changes, Invertebrates, Origins, Shells, Thin Sections, ...7.0167

DRAINAGE PATTERN DEVELOPMENT ON TIDAL MARSHES ...Aerial Photography, Drainage, Swamps-marshes, ...7.0291

Environments - Animal

Chemical Measurements -water

MEASUREMENT OF BIOLOGICAL FACTORS OF VARIOUS HABITATS, AND THEIR RELATION TO THE BIOLOGY OF THE COMMERCIALLY IMPORTANT SPECIES ...Habitat Studies, Physical Measurements -water, Plankton (non-specific), Population Dynamics, Productivity - Food Chain, ...5.0219

FISH POPULATION STUDY ...Commercial Fishing, Fish -non-specific, Food Supply, Population Dynamics, Water Temperature-non-specific, ...5.0174

PHYSIOLOGY AND BEHAVIOR ...Behavior, Environmental Physiology, Lake Michigan, Physical Measurements -water, Productivity - Food Chain, ...5.0904

Contamination - Water

THE ACCUMULATION OF FISSION PRODUCTS BY MARINE FISH AND SHELLFISH ...Chlorideae (non-specific & Ot), Estuaries, Food Chains, Radioactivity-general, Radioecology, ...6.0167

ECOLOGICAL STUDIES OF RADIOACTIVITY IN THE COLUMBIA RIVER ESTUARY AND ADJACENT PACIFIC OCEAN ...Columbia River, Organism Sampling Devices, Pacific Ocean-north, Pollutants - Path of , Radioactivity-general, ...6.0172

COLUMBIA RIVER STUDIES ...Columbia River, Invertebrates, Oysters, Pollution Effects, Radioactivity-general, Reproductive System, ...5.0518

EFFECTS OF LOG RAFTING ON DUNGENESS CRAB ...Crabs, Diving and Scuba, Forestry, Mans Activities, Pulp, Paper , and Logging, ...5.0347

DETERMINATION OF SAFE LEVELS OF POLLUTION IN PUERTO RICO ...Bays, Meteorological Studies-general, Pollution - Effects of , Puerto Rico, Recreation Sites, Water Properties-general, ...6.0181

ESTUARINE WATER QUALITY AND FISH DISTRIBUTION ...Environmental Physiology, Estuaries, Pollution Effects, Pulp, Paper , and Logging, Salmon & Trout - Non-specific, ...5.0178

EFFECTS OF KRAFT PULP MILL EFFLUENTS ON THE GROWTH AND PRODUCTION OF FISH ...Industrial Wastes, Pollution - Effects of , Pollution Effects, Population Dynamics, Pulp, Paper , and Logging, Salmon & Trout - Non-specific, ...5.0311

EFFECT OF EURASIAN WATERMILFOIL CONTROL PROCEDURES ON WILDLIFE AND OTHER ORGANISMS IN AQUATIC ENVIRONMENTS ...Diquat, Evaluation, Water Milfoil, Waterweed... , 2,4-d, ...5.0700

ACCUMULATION OF RADIOACTIVITY BY INVERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Cooperative-studies, Diagnostic Procedures, Radioactivity-general, Reactor Sites & Rad Waste, ...5.0474

ACCUMULATION OF RADIONUCLIDES BY VERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Biological, Estuaries, Radioactivity-general, ...**5.0293**

ACCUMULATION OF RADIOACTIVITY BY ORGANISMS IN EXPERIMENTAL MARINE ENVIRONMENTS ...Cooperative-studies, Estuaries, Laboratory, Radioactivity, ...**5.0911**

EFFECTS OF CHEMICALS ON THE PHYSIOLOGY OF SEA LAMPREY AMMOCETES (PETROMYZON MARINUS) ...Control of Nuisance Species, Environmental Physiology, Lampreys, Maturity & Growth Stages, ...**5.0631**

LABORATORY BIOASSAYS ...Fish, Laboratory, Laboratory Animals, Pollution - Effects of , Pollution Sources-general, ...**5.0882**

FISH HOLDING AND LIFE STAGE SENSITIVITY STUDIES ...Environment Resistance, Fish, Fish -non-specific, Great Lakes-general, Maturity & Growth Stages, ...**5.0276**

ENVIRONMENTAL CONDITIONS AND POPULATION DYNAMICS IN SELECTED UNPOLLUTED ESTUARIAL AND COASTAL AREAS ...Aquatic Ecology, Habitat Studies, Marine Biology (non-specific), Pollution - Effects of , Toxic Substances -non-specific, ...**5.0922**

MARINE BIOLOGICAL ASSESSMENT OF POLLUTIONAL FATE ...Crustacea -non-specific, Fish -non-specific, Nets, Pollution - Effects of , ...**6.0176**

HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE FISHES ...Killifishs - Cyprinodon, Pathology, Pollution - Effects of , Pollution Effects, ...**5.0323**

HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE INVERTEBRATES ...Clams, Invertebrate Pathology, Pathology, Pollution - Effects of , Pollution Effects, Pollution Sources-other, ...**5.0497**

PHARMACOLOGY OF METAL POISONING IN ESTUARINE FISHES ...Estuaries, Killifishs - Cyprinodon, Metals -non-specific, Stress, ...**5.0324**

EFFECTS OF PETROLEUM AND PETROLEUM WASTES UPON IMPORTANT SPECIES OF ESTUARINE PHYTOPLANKTON AND ZOOPLANKTON ...Contamination, Pollution-water, Estuaries, Oil, Oil and Natural Gas - Sulfur, Phytoplankton, Zooplankton, ...**5.0830**

PURIFICATION OF HARD CLAMS FROM POLLUTED WATERS ...Animal Viruses (non-specific), Clams, Estuaries, Intestinal Bacteria, New Jersey, ...**5.0467**

Energy Budgets

EXPERIMENTAL STUDIES ON THE BIOLOGY AND FOOD CHAIN ECONOMICS OF THE CHAETOGNATHS ...Productivity - Food Chain, Reproductive System, Whole Body Culture & Rearing, Zooplankton, ...**5.0777**

METABOLISM OF MARINE ECOSYSTEMS ...Food Webs, Metabolism, Other, Plankton (non-specific), Productivity - Food Chain, ...**5.0966**

METABOLISM OF COMPLETE WATER COLUMNS ...Antarctic Ocean, Autotrophic, Metabolism, Respiration, ...**5.0967**

CALORIC STUDIES OF SPARTINA AND THE MARSH CRAB SESARMA RETICULATUM ...Calorimetry, Chlorideae (non-specific & Ot), Crabs, Swamps-marshes, ...**5.0380**

ENERGY AND ELEMENT TRANSFER IN LOWER MARINE TROPHIC LEVELS ...Copepods, Oregon, Phytoplankton, ...**5.0823**

BIOCHEMICAL AND BIOPHYSICAL STUDIES OF THE MARINE ENVIRONMENT ...Copepods, Energy, Organics, Productivity - Food Chain, ...**5.0767**

PHYSIOLOGICAL VARIATION AND ECOLOGY OF MOLLUSCS ...Gastropods -slugs,conch,snails, Metabolism, Population Dynamics, Reproductive System, Respiratory System, ...**5.0472**

ENERGY TRANSFER IN LOWER MARINE TROPHIC LEVELS ...Aquatic Ecology, Environmental Ecology, Productivity - Food Chain, Vertical Distribution, ...**5.1020**

Gases, Dissolved -water

EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...Aquatic Ecology, Columbia River, Migration, Mortality Rates, Nitrogen, Salmon & Trout - Non-specific, ...**5.0221**

EFFECTS OF HIGH TEMPERATURE, LOW OXYGEN, AND PH EXTREMES ON THE SURVIVAL OF AQUATIC INSECTS AND CRUSTACEA IMPORTANT AS TROUT FOOD ...Aquatic Ecology, Food Supply, High Temp. -85f Or Above, Lake Superior, Ph, Acidity -water, ...**5.0464**

Gravity

SIMULATED WEIGHTLESSNESS IN FISH ...Behavior, Cardiovascular System, Fish -non-specific, Gravitational Fields, Proprioceptors, ...**5.0275**

Light -other

CUES INVOLVED IN VERTICAL MOVEMENT AND STATIC ORIENTATION OF GASTROPODS ...Behavior, Gastropods -slugs,conch,snails, Invertebrate Physiology, Locomotion, ...**5.0462**

THE STRUCTURE AND FUNCTION OF CRUSTACEAN EYES ...Crustacea -non-specific, Invertebrate Anatomy, Oceanic - Pelagic, Vertical Distribution, Visual Organs, ...**5.0363**

Light Quality

Light Quality -non-specific

THE SPECTRAL SENSITIVITY OF THE GREEN SEA TURTLE (CHELONIA MYDAS) ...Turtles, Terrapins, Tortoises, Visual Organs, ...**5.0560**

Light Quantity Or Intensity

Darkness

RETINAL RHYTHMS UNDER CONTROLLED LIGHT ...Bluefish, Histology and Cytology, Light Quantity -non-specific, Visual, Visual Organs, ...**5.0282**

Light Quantity -non-specific

RETINAL RHYTHMS UNDER CONTROLLED LIGHT ...Bluefish, Darkness, Histology and Cytology, Visual, Visual Organs, ...**5.0282**

Magnetic Impulses

DISTANT GOAL ORIENTATION ...Biological Rhythms, Birds -non-specific, Locomotion -animal, Mark, Tag Or Capture -other, Orientation, ...**4.0109**

Mineral Content -water

PRELIMINARY MODIFICATIONS AND CONTROL OF NATURAL GROWING AREA ENVIRONMENTS ...Captive Rearing, Clams, Growth Rate, Oysters, Predation, ...**5.0495**

Organic Matter Content -water

ECOLOGICAL SIGNIFICANCE OF PARTICULATE MATTER IN THE SEA ...Atlantic Ocean-north, Interbiotic Relat.(non-specif), Marine Bacteria, Temporal Distribution, Vertical Distribution, Zooplankton, ...**5.0754**

Ph, Acidity -water

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...Basic Embryology, Behavior, Clams, Maturity & Growth Stages, Oysters, ...**5.0373**

EFFECTS OF HIGH TEMPERATURE, LOW OXYGEN, AND PH EXTREMES ON THE SURVIVAL OF AQUATIC INSECTS AND CRUSTACEA IMPORTANT AS TROUT FOOD ...Aquatic Ecology, Food Supply, Gases, Dissolved -water, High Temp. -85f Or Above, Lake Superior, ...**5.0464**

Photoperiod

LIGHT AND DARK ADAPTION IN THE RETINAE OF YOUNG BLUEFISH ...Adaptation, Bluefish, Retina, Visual Organs, ...**5.0283**

RHYTHMIC ACTIVITY OF BLUEFISH IN RELATION TO NORMAL LIGHT REGIME ...Biological Rhythms, Bluefish, Environmental Physiology, Locomotion -animal, ...**5.0285**

RHYTHMIC ACTIVITY OF BLUEFISH UNDER EXPERIMENTALLY VARIED LIGHT REGIMES ...Adaptation, Biological Rhythms, Bluefish, Environmental Physiology, Water Light Quality & Quantity, ...**5.0286**

Physical Measurements -water

MEASUREMENT OF BIOLOGICAL FACTORS OF VARIOUS HABITATS, AND THEIR RELATION TO THE BIOLOGY OF THE COMMERCIALLY IMPORTANT SPECIES ...Chemical Measurements -water, Habitat Studies, Plankton (non-specific), Population Dynamics, Productivity - Food Chain, ...**5.0219**

PHYSIOLOGY AND BEHAVIOR ...Behavior, Chemical Measurements -water, Environmental Physiology, Lake Michigan, Productivity - Food Chain, ...**5.0904**

Radioactive Fallout

PHYSICAL AND RADIOLOGICAL CHEMISTRY OF OCEAN SOLUTIONS ...Chemical Reactions, Octopus, Squid, Cuttlefish... , Pacific Ocean-north, Radioactivity-general, Tracers, ...1.0133

THE EFFECTS OF RADIATION ON THE PHYSIOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Cooperative-studies, ...5.0294

Seasonal

Spring

SPRING DISTRIBUTION OF FISHES ...Commercial Fishing, Continental Shelf, Data Acquisition, Environmental Ecology, Fish -non-specific, Temporal Distribution, ...5.0154

Winter

EFFECT OF PROCESS ON SHELLFISH ...Clams, Processed Product Quality, Processing, Sanitation, Shelf Life & Storage, ...6.0059

WINTER DISTRIBUTION OF FISHES ...Continental Shelf, Environmental Ecology, Fish -non-specific, Salinity, Temperature, Temporal Distribution, ...5.0153

Temperature -water

High Temp. -85f Or Above

EFFECTS OF HOT WATER MASSES ON MARINE FISHES ...Atlantic Ocean-north, Behavior, Fish -non-specific, Oceanic Fronts, Thermal, ...5.0210

EFFECTS OF HIGH TEMPERATURE, LOW OXYGEN, AND PH EXTREMES ON THE SURVIVAL OF AQUATIC INSECTS AND CRUSTACEA IMPORTANT AS TROUT FOOD ...Aquatic Ecology, Food Supply, Gases, Dissolved -water, Lake Superior, Ph, Acidity -water, ...5.0464

Low Temp. -but Above 32f

LIPID COMPOSITION OF ANTARCTIC MARINE ORGANISMS AND SEA WATER ...Antarctic Ocean, Fish -non-specific, Gulf of Mexico, Lipids, Phytoplankton, Productivity - Food Chain, Zooplankton, ...5.1031

THE PURCHASE AND INTRODUCTION OF BROOD STOCK ...Oysters, Ponds, Spawning & Nesting Sites, Stocking of Fish & Shellfish, Warm Water, ...8.0026

RELATION OF TEMPERATURE TO RHYTHMIC BEHAVIOR ...Behavior, Biological Rhythms, Bluefish, Environmental Physiology, Locomotion -animal, ...5.0284

ESTUARINE BIOLOGY--RESPONSE OF LARVAE TO TEMPERATURE AND SALINITY ...Alewife,menhaden,shad,herring, Captive Rearing, Estuaries, Longevity, Maturity & Growth Stages, Water Salinity, ...5.0213

PREDICTION OF ENVIRONMENT ...Biological-general, Columbia River, Environmental Ecology, Physical-general, Reservoirs and Impoundments, Salmon & Trout - Non-specific, Snake River, Temperature, Thermal Pollution, ...5.0225

FISHERY FORECASTING - TEMPERATE FISHERIES ...Circulation-general, General Synoptic Observations, Pacific Ocean-east, Temperature, ...5.0197

INITIATION OF METAMORPHOSIS IN AURELIA ...Biological Rhythms, Growth Rate, Jelly Fish, Metabolism, Water Light Quality & Quantity, ...5.0599

Warm Water

AQUATIC MYXOBACTERIA - CHONDROCOCCUS COLUMNARIS ...Atlantic Salmon, Sebago Salmon, Identification, Myxobacteria, Pathology, ...5.0848

THE PURCHASE AND INTRODUCTION OF BROOD STOCK ...Low Temp. -but Above 32f, Oysters, Ponds, Spawning & Nesting Sites, Stocking of Fish & Shellfish, ...8.0026

REPOPULATION OF DECIMATED SECTIONS OF WARMWATER STREAMS BY LONGEAR SUNFISH, LEPOMIS MEGALOTIS (RAFINESQUE) ...Aquatic Ecology, Population Dynamics, Stocking of Fish & Shellfish, Streams, Sunfish, Rock & Roanoke Bass.., ...5.0097

Water Temperature-non-specific

EFFECTS OF IRRADIATION, TEMPERATURE AND OTHER ENVIRONMENTAL FACTORS ON SALMONID EMBRYOS ...Basic Embryology, Radiation Effects-non-specific, Salmon & Trout - Non-specific, Water Light Quality & Quantity, X and Gamma Rays, ...5.0336

TEMPERATURE NEEDS FOR GONADAL DEVELOPMENT AND SPAWNING OF DIFFERENT PHYSIOLOGICAL RACES OF THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA ...Behavior, Biological Rhythms, Environmental Physiology, Oysters, Reproductive System, ...5.0352

EVOLUTIONARY DIVERGENCE OF ONUPHID POLYCHAETES ...Comparative Physiology, Environment Resistance, Environmental Physiology, Invertebrate Nutrition, Lugworms, Marine Segmentedworm, ...5.0663

ZOOPHYSIOLOGY OF OCEANIC BENTHIC ANIMALS OFF THE NORTH CAROLINA COAST ...Adaptation, Atlantic Ocean-north, Benthic Fauna, Benthonic-bottom, Environmental Physiology, ...5.1009

THERMALMETABOLIC RELATIONSHIPS OF STENOTHERMAL FISHES ...Antarctica, Environmental Physiology, Fish - non-specific, Proprioceptors, Thermonegulation, Water Pressure, ...5.0312

LOCATION OF INSHORE SPAWNING AREAS ...Bluefish, Long Island Sound, Nets, Spawning & Nesting Sites, ...5.0201

CHEMICAL AND PHYSICAL DATA ...Fish -non-specific, Population Dynamics, Temperature, Turbidity & Suspended Matter, Water Movement, Currents,, Water Salinity, ...5.0207

A STUDY OF THE ICHTHYOPLANKTON ASSOCIATED WITH TWO OF NEW JERSEYS COASTAL INLETS ...Estuaries, Nets, Salinity, Thermal, Water Salinity, Zooplankton, ...5.0806

THE INFLUENCE OF ENVIRONMENTAL FACTORS UPON DEVELOPING MERISTIC STRUCTURES IN THE MARINE FISH, FUNDULUS MAJALIS (WALBAUM) ...Basic Embryology, Developmental Physiology, Environmental Physiology, Killifishs - Cyprinodon, ...5.0298

MARINE SPORTS FISHES RESEARCH ...Delaware Bay, Fish - other, Killifishs - Cyprinodon, Population Dynamics, Water Salinity, ...5.0248

RELATIONSHIP BETWEEN WATER TEMPERATURE AND SIZE OF PARASITIC COPEPODS ...Collections, Copepods, Host Specificity, Size, Temperature, ...5.0390

TEMPERATURE TOLERANCE OF MARINE ANIMALS THROUGH BEHAVORIAL RESPONSES ...Behavior, Environment Resistance, Mortality Rates, Thermal, ...5.0118

THERMAL PREFERENCES OF MARINE FISHES AND INVERTEBRATES ...Behavior, Fish -non-specific, Invertebrates - non-specific, Thermal, ...5.0209

EFFECT OF TEMPERATURES AND CIRCULATION OF CONTINENTAL SHELF WATERS ON THE DISTRIBUTION OF FISHES ...Continental Shelf, Fish -non-specific, Surface Environments, Temperature, Water Movement, Currents,, ...4.0165

LIFE HISTORY OF CLUPEA HARENGUS PALLASI ...Alewife,menhaden,shad,herring, Aquaculture & Fish-farming, Artifical Insemination, Life History Studies, Water Salinity, ...5.0035

HYPOTHETICAL DISTRIBUTION OF 14 SPECIES OF ATLANTIC COASTAL GAME FISHES ...Aquatic Ecology, Atlantic Ocean-general, Environmental Ecology, Fish -other, ...5.0123

FISH POPULATION STUDY ...Chemical Measurements -water, Commercial Fishing, Fish -non-specific, Food Supply, Population Dynamics, ...5.0174

INVESTIGATE SEASONAL VARIATIONS, SURFACE WATER TYPES, HAWAIIAN AREA (KOKO HEAD) ...Commercial Fishing, Hawaii, Heat and Radiation Transfer, Oceanic Fronts, Salinity, Temperature, Tuna, Mackerel, Albacore... Water Salinity, ...1.0148

MONITORING SURVEY AND TIME-SERIES ANALYSIS OF SUBSURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN ...Pacific Ocean-north, Subsurface Environments, Temperature, Thermocline, ...1.0176

PINK SALMON INVESTIGATIONS - EARLY SEA LIFE OF SALMON ...Alaska, Environmental Physiology, Life History Studies, Parasitology -other, ...5.0187

SCRIPPS TUNA OCEANOGRAPHY RESEARCH PROGRAM ...Food Supply, Pacific Ocean-east, Temperature, Tropic, Tuna, Mackerel, Albacore..., ...5.0200

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON ...Copepods, Oxygen, Water Salinity, Zooplankton, ...5.0835

AERIAL SEA SURFACE TEMPERATURE SURVEYS OF U S. COASTAL WATERS ...Aircraft, Infrared Radiation, Migration, Productivity - Food Chain, Temperature, ...4.0148

THERMAL ACCLIMATION PATTERNS IN PARASITES AND HOSTS ...Adaptation, Host Resistance, Host Specificity, Life History Studies, Monogenea, ...5.0643

OSMOTIC COMPONENTS IN ELASMOBRANCH BLOOD ...Blood Plasma and Serum, Chondrichthyes -other, Environmental Physiology, Osmoregulation, Water Salinity, ...5.0249

Turbidity & Suspended Matter

CHEMICAL AND PHYSICAL DATA ...Fish -non-specific, Population Dynamics, Temperature, Water Movement, Currents,, Water Salinity, Water Temperature-non-specific, ...5.0207

EVALUATION OF HABITAT ALTERATION, CURRITUCK SOUND ...Fish -non-specific, Habitat Studies, North Carolina, Water Salinity, ...5.0914

Types of Animal Environments

Islands

ECOLOGY OF STORM PETRELS ...Albatrosses, Shearwaters... , California, Mark, Tag Or Capture -other, Spawning & Nesting Sites, Terrestrial Ecology, ...5.0532

PACIFIC OCEAN BIOLOGICAL SURVEY PROGRAM ...Birds - non-specific, Meteorological Studies, Pacific Ocean-general, Vertical Distribution, ...5.0568

Laboratory

LARVAL DEVELOPMENT OF SCYLLARIDEAN LOBSTERS ...Animal Taxonomy, Developmental Physiology, Environmental Physiology, Invertebrate Nutrition, Lobsters, ...5.0409

REPRODUCTION AND EMBRYONIC SURVIVAL IN ASCIDIA NIGRA (SAVIGNY) ...Basic Embryology, Biological Rhythms, Reproductive System, Sea Squirts - Tunicates, Whole Body Culture & Rearing, ...5.0600

ACCUMULATION OF RADIOACTIVITY BY ORGANISMS IN EXPERIMENTAL MARINE ENVIRONMENTS ...Contamination - Water, Cooperative-studies, Estuaries, Radioactivity, ...5.0911

LABORATORY BIOASSAYS ...Contamination - Water, Fish, Laboratory Animals, Pollution - Effects of , Pollution Sources-general, ...5.0882

Water Environment -other

SHARK ATTACKS ...Behavioral Ecology, Diving and Scuba, Sharks, ...6.0090

ECOLOGY OF ECHINOIDS ...Behavioral Ecology, Benthonic-bottom, Sea Urchins & Other Echinoderm, Vertical Distribution, ...5.0571

JUVENILE MIGRATION RATES ...Columbia River, Mark, Tag Or Capture -other, Migration, Salmon & Trout - Non-specific, Snake River, ...5.0223

EARLY LIFE HISTORY OF COREGONIDS ...Cisco, Lake Herring, Environmental Ecology, Life History Studies, Maturity & Growth Stages, Technique Development, ...5.0110

FISH GUIDING ...Animal Distr. (non-specific), Control Systems, Fish -non-specific, Instrumental Services, Management -other, ...8.0015

SPACE APPLICATIONS TO FISHERIES OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM) ...Commercial Fishing, Computer Applications, Forecasting-prediction, Satellites, ...4.0172

FOOD AND EXPERIMENTAL ENVIRONMENTS (SHRIMP AQUACULTURE PROGRAM) ...Aquaculture & Fish-farming, Captive Rearing, Digestive System, Food Supply, Shrimps - Common, ...5.0505

INVESTIGATE POPULATION DYNAMICS OF ALBACORE ...American Samoa, Commercial Fishing, Population Dynamics, Tuna, Mackerel, Albacore... , ...5.0081

THE OCEANOGRAPHY OF NEW ENGLAND FISHING BANKS ...Continental Shelf, Fish -other, Number Or Density, Vertical Distribution, ...5.0901

ESTURAINE ECOLOGY--INDIAN RIVER, DELAWARE ...Delaware, Estuaries, Tidewater Areas, ...5.0875

Water Light Quality & Quantity

EFFECTS OF IRRADIATION, TEMPERATURE AND OTHER ENVIRONMENTAL FACTORS ON SALMONID EMBRYOS ...Basic Embryology, Radiation Effects-non-specific, Salmon & Trout - Non-specific, Water Temperature-non-specific, X and Gamma Rays, ...5.0336

RHYTHMIC ACTIVITY OF BLUEFISH UNDER EXPERIMENTALLY VARIED LIGHT REGIMES ...Adaptation, Biological Rhythms, Bluefish, Environmental Physiology, Photoperiod, ...5.0286

INITIATION OF METAMORPHOSIS IN AURELIA ...Biological Rhythms, Growth Rate, Jelly Fish, Low Temp. -but Above 32f, Metabolism, ...5.0599

Water Movement, Currents,

LANGMUIR CIRCULATION AND PLANKTON ECOLOGY ...Circulation-general, Phytoplankton, Range Or Territorial Distr. , Vertical Distribution, Wind Or Air Movement, Zooplankton, ...5.0794

SHRIMP PRODUCTION IN LOUISIANA SALT-MARSH IMPOUNDMENTS UNDER EXISTING AND MANAGED CONDITIONS ...Aquaculture & Fish-farming, Captive Rearing, Lagoons, Louisiana, Shrimps - Common, ...5.0435

CHEMICAL AND PHYSICAL DATA ...Fish -non-specific, Population Dynamics, Temperature, Turbidity & Suspended Matter, Water Salinity, Water Temperature-non-specific, ...5.0207

EFFECT OF TEMPERATURES AND CIRCULATION OF CONTINENTAL SHELF WATERS ON THE DISTRIBUTION OF FISHES ...Continental Shelf, Fish -non-specific, Surface Environments, Temperature, Water Temperature-non-specific, ...4.0165

Water Pressure

STUDIES IN THE PHYSIOLOGY AND BIOCHEMISTRY OF DEEP-SEA FISHES ...Environmental Physiology, Fish -non-specific, Metabolism, Vertical Distribution, ...5.0237

ENERGY REQUIREMENTS OF MARINE ORGANISMS ...Energy, Sharks, Thermonegulation, Tuna, Mackerel, Albacore... , ...5.0273

THERMALMETABOLIC RELATIONSHIPS OF STENOTHERMAL FISHES ...Antarctica, Environmental Physiology, Fish - non-specific, Proprioceptors, Thermonegulation, Water Temperature-non-specific, ...5.0312

DEEP DIVING ANTARCTIC BIRDS AND MAMMALS ...Adaptation, Antarctica, Locomotion -animal, Penguins, Seals, ...5.0555

PRESSURE EFFECTS ON MARINE ORGANISMS ...Abyssal, Environmental Physiology, Pressure, Vertical Distribution, ...5.0943

MARINE PHYSIOLOGY ...Cardiovascular System, Fish, Osmoregulation, Thermonegulation, ...5.0947

Water Salinity

CHEMICAL AND PHYSICAL DATA ...Fish -non-specific, Population Dynamics, Temperature, Turbidity & Suspended Matter, Water Movement, Currents,, Water Temperature-non-specific, ...5.0207

EVALUATION OF HABITAT ALTERATION, CURRITUCK SOUND ...Fish -non-specific, Habitat Studies, North Carolina, Turbidity & Suspended Matter, ...5.0914

A STUDY OF THE ICHTHYOPLANKTON ASSOCIATED WITH TWO OF THE NEW JERSEYS COASTAL INLETS ...Estuaries, Nets, Salinity, Thermal, Water Temperature-non-specific, Zooplankton, ...5.0806

MARINE SPORTS FISHES RESEARCH ...Delaware Bay, Fish - other, Killifishs - Cyprinodon, Population Dynamics, Water Temperature-non-specific, ...5.0248

MOVEMENTS OF FRESHWATER CATFISH IN THE ESTUARIES OF SOUTHWEST LOUISIANA ...Blue Catfish, White Catfish, Environment Resistance, Estuaries, Louisiana, Migration, ...5.0090

EPIDEMIOLOGY OF SALMON POISONING DISEASE ...Epizootic, Helminths, Infectious Conditions and Dis, Pathology, Salmon & Trout - Non-specific, ...5.0306

OCEAN WATER INTRUSION INTO BACK BAY, VIRGINIA, & CURRITUCK SOUND, NORTH CAROLINA, ON THE WATERFOWL & FRESHWATER FISH HABITAT ...Habitat Studies, North Carolina, Virginia, Waterfowl -non-specific, ...5.0897

LIFE HISTORY OF CLUPEA HARENGUS PALLASI ...Alewife,menhaden,shad,herring, Aquaculture & Fish-farming, Artifical Insemination, Life History Studies, Water Temperature-non-specific, ...5.0035

ESTUARINE BIOLOGY--RESPONSE OF LARVAE TO TEMPERATURE AND SALINITY ...Alewife,menhaden,shad,herring, Captive Rearing, Estuaries, Longevity, Low Temp. -but Above 32f, Maturity & Growth Stages, ...5.0213

PINK SALMON INVESTIGATIONS - INTERTIDAL ECOLOGY ...Alaska, Life History Studies, Salmon -coho,chinook,sockeye..., Spawning & Nesting Sites, Tidal Streams, ...5.0186

INVESTIGATE SEASONAL VARIATIONS, SURFACE WATER TYPES, HAWAIIAN AREA (KOKO HEAD) ...Commercial Fishing, Hawaii, Heat and Radiation Transfer, Oceanic Fronts, Salinity, Temperature, Tuna, Mackerel, Albacore... , Water Temperature-non-specific, ...1.0148

DROPOUT OF SALMON FROM GILL NETS ...Commercial Fishing, Management -other, Mortality Rates, Nets, Salmon & Trout - Non-specific, ...5.0177

GROWTH, CONDITION, AND SURVIVAL OF SHELLFISH ...Adaptation, Environmental Physiology, Maryland, Oysters, Water Quality-general, ...5.0447

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON ...Copepods, Oxygen, Water Temperature-non-specific, Zooplankton, ...5.0835

FUNCTION OF THE INTERRENAL GLAND IN TELEOST FISHES ...Blood Cells, Kidney and Urinary System, Osmoregulation, Pituitary, Tilapia, Cichlids, ...5.0233

OSMOTIC COMPONENTS IN ELASMOBRANCH BLOOD ...Blood Plasma and Serum, Chondrichthyes -other, Environmental Physiology, Osmoregulation, Water Temperature-non-specific, ...5.0249

OPERANT OSMOTIC REGULATION IN A MARINE ANIMAL ...Environment Resistance, Learning and Retention, Octopus, Squid, Cuttlefish... , Osmoregulation, ...5.0664

Wind Or Air Movement

LANGMUIR CIRCULATION AND PLANKTON ECOLOGY ...Circulation-general, Phytoplankton, Range Or Territorial Distr. , Vertical Distribution, Water Movement, Currents,, Zooplankton, ...5.0794

Environments - Plant

Contamination, Pollution-water

EFFECTS OF PETROLEUM AND PETROLEUM WASTES UPON IMPORTANT SPECIES OF ESTUARINE PHYTOPLANKTON AND ZOOPLANKTON ...Contamination - Water, Estuaries, Oil, Oil and Natural Gas Sulfur, Phytoplankton, Zooplankton, ...5.0830

ISOLATION AND TAXONOMY OF YEASTS IN LAKES AND SEWAGE ...Bioindicators, Plant Taxonomy, Streams, Yeasts (non-specific), ...5.0787

Energy Budgets

ORGANIC PRODUCTION OF EPIFAUNAL ORGANISMS ...Epiphytic Relationships, Marine Biology (non-specific), Organics, Plant Ecosystems(non-specific), Primary Productivity, Reefs, ...5.1032

CALORIC STUDIES OF SPARTINA AND THE MARSH CRAB SESARMA RETICULATUM ...Calorimetry, Chlorideae (non-specific & Ot), Crabs, Swamps-marshes, ...5.0380

ENERGETICS OF PALAEMONETES PUGIO AND THE WEEDBED COMMUNITY OF SOUTH CREEK ESTUARY ...Aquatic Vegetation -ns, Estuaries, Habitat Studies, North Carolina, Shrimps - Common, ...5.0482

ENERGY AND ELEMENT TRANSFER IN LOWER MARINE TROPHIC LEVELS ...Copepods, Oregon, Phytoplankton, ...5.0823

Mineral Content -water

STUDIES ON INORGANIC NUTRIENT ASSIMILATION RATES IN ESTUARINE PONDS ...Estuaries, Nitrogen, Nutrients, Phosphorus, Self-purification, ...5.0991

Oxygen Content -water

MEASUREMENTS OF OXYGEN CONSUMPTION BY THE SEA BED IN DEEP WATER OF PUGET SOUND ...Benthic Flora, Chemistry, Oxygen, Puget Sound, ...5.1036

OXYGEN RESOURCES OF TIDAL WATERS ...Autotrophic, Marine Biology (non-specific), Oxygen, Pollution Sources-general, Tides, ...1.0119

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THE ENVIRONMENTAL REQUIREMENTS OF MARINE PLANKTONIC ORGANISMS ...Bulk Culture -other, Marine Biology (non-specific), Plankton (non-specific), Water Salinity, Water Temperature -other, ...5.0921

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ARCTIC BIOLOGICAL OCEANOGRAPHY ...Adaptation, Arctic Ocean, Growth and Differentiation, Phytoplankton, Potamogeton, Ruppia, Zostera... Water - Light Qual. & Quant. ...5.0853

THE ENVIRONMENTAL REQUIREMENTS OF MARINE PLANKTONIC ORGANISMS ...Bulk Culture -other, Marine Biology (non-specific), pH -water, Plankton (non-specific), Water Salinity, ...5.0921

Types of Plant Environments

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A UNIFIED APPROACH TO WATER, FOOD AND POWER IN A COASTAL DESERT COMMUNITY ...Arid and Desert, Desalination, Deserts, Diesel, Distilling Units, Electric Power Plants, Use of Impaired Water, ...7.0002

Water - Light Qual. & Quant.

ARCTIC BIOLOGICAL OCEANOGRAPHY ...Adaptation, Arctic Ocean, Growth and Differentiation, Phytoplankton, Potamogeton, Ruppia, Zostera.., Water Temperature -other, ...5.0853

Water Depth, Water Levels

THE EFFECTS OF POLLUTION ON BENTHIC MARINE PLANT COMMUNITIES ...Bays, Habitat Studies, ...5.0724

CHANGES IN THE LIMITING NUTRIENT DUE TO TEMPORAL, GEOGRAPHIC, AND DEPTH VARIATIONS ...Depth, New York, Nutrients, Phytoplankton, Sub - Tropic, ...5.1004

Water Salinity

MACROMOLECULAR BASIS FOR ADAPTATION TO SALINITY CHANGES IN PRYMNESIUM PARVUM ...Adaptation, Growth Rate, Ionic Effect, Permeability, Prymnesium, ...5.1012

THE ENVIRONMENTAL REQUIREMENTS OF MARINE PLANKTONIC ORGANISMS ...Bulk Culture -other, Marine Biology (non-specific), pH -water, Plankton (non-specific), Water Temperature -other, ...5.0921

Enzyme Studies

Comparative Enzymology

Developmental Stages

PRESENCE OF ENZYMES RELATED TO DNA SYNTHESIS IN EGGS OF ECHINODERMS ...Basic Embryology, DNA Polymerase, Enzyme Formation, Nucleoside Kinase, Sea Urchins & Other Echinoderm, ...5.1034

FORMATION AND METABOLISM OF NEUROHUMORAL TRANSMITTER SUBSTANCES IN MARINE ANIMALS ...Basic Studies, Biochemical, Quantitative & Qualitative, Sharks, ...5.0980

Species

CHEMISTRY AND ENZYMOLOGY OF BIOLUMINESCENCE ...Anthozoa, Bioluminescence, Earthworms, Kinetics -other, Luminous Bacteria, ...5.0962

ENZYME STRUCTURE AND ITS RELATION TO TAXONOMY ...Animal Taxonomy, Conformational Studies, Echinodermata -other, Enzymes -non-specific, ...5.0654

Conformational Studies

ENZYME STRUCTURE AND ITS RELATION TO TAXONOMY ...Animal Taxonomy, Echinodermata -other, Enzymes -non-specific, Species, ...5.0654

Enzyme Formation

PRESENCE OF ENZYMES RELATED TO DNA SYNTHESIS IN EGGS OF ECHINODERMS ...Basic Embryology, Developmental Stages, DNA Polymerase, Nucleoside Kinase, Sea Urchins & Other Echinoderm, ...5.1034

Enzyme Studies

Interaction

Enzyme-substrate

MECHANISM STUDIES ON BIOLUMENESCENT REACTIONS WITH EMPHASIS ON ENERGY TRANSFER PROBLEMS ...Bioluminescence, Energy Conversion, Luciferase, Luciferin, ...1.0164

FORMATION AND UTILIZATION OF TERPENES ...Anthozoa, Biosynthesis, Symbiosis, Terpenes, Zooxanthella, ...5.0957

MODE OF ACTION OF MARINE TOXINS ...Animal Toxins, Antigen, Blood Globulins, Sea Urchins & Other Echinoderm, ...6.0103

BIOCHEMICAL CHARACTERIZATION OF CHOLINESTERASES IN THE BLOOD ANDCENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Blood and Lymph, Cholinesterase, Horseshoe Or King Crabs, Nervous System, Reaction Rates, ...5.0468

Inhibitors

INTERACTION OF PROTEINS WITH METAL AND HYDROGEN IONS ...Globin -incl. myoglobin, Metallic Ions, Neurophysin, Photochemistry, Ribonuclease, ...5.0999

Isoenzymes

LOW TEMPERATURE GROWTH OF BACTERIA ON FOODS ...Cryophilic Bacteria, Fish -non-specific, Growth (non-specific & Ot.), Microbiological, Refrigeration, Temperature, ...6.0086

Kinetics - Mechanisms

Inactivation

INVESTIGATION OF FEASIBILITY OF STERILIZING FISH BY RADIATION ...Enzymatic, Fish -non-specific, Organoleptic Studies, Radiation, Shelf Life & Storage, ...6.0041

Kinetics -other

CHEMISTRY AND ENZYMOLOGY OF BIOLUMINESCENCE ...Anthozoa, Bioluminescence, Earthworms, Luminous Bacteria, Species, ...5.0962

Reaction Rates

THE ROLE OF MARINE ORGANISMS IN THE DEGRADATION OF NAVAL MATERIALS ...Biological, Marine Bacteria, Materials Used Undersea, Model Studies, ...8.0241

ELUCIDATION OF THE METABOLIC PATHWAYS OF MARINE PLANKTONIC ORGANISMS ...Marine Biology (non-specific), Metabolism (intracellular), Organelle-enzyme Assn, Plankton (non-specific), Purification & Isolate, ...5.0828

BIOCHEMICAL CHARACTERIZATION OF CHOLINESTERASES IN THE BLOOD ANDCENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Blood and Lymph, Cholinesterase, Enzyme-substrate, Horseshoe Or King Crabs, Nervous System, ...5.0468

Thermodynamics

RESEARCH STUDIES IN MOLECULAR PHARMACOLOGY ...Anesthetic, Bonding and Binding, Diving and Scuba, Mechanism of Action, Permeability, ...6.0100

Organelle-enzyme Assn

A HISTOCHEMICAL STUDY OF THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Cholinesterase, Histochemistry - Cytochem, Horseshoe Or King Crabs, Nervous System, ...5.1000

ELUCIDATION OF THE METABOLIC PATHWAYS OF MARINE PLANKTONIC ORGANISMS ...Marine Biology (non-specific), Metabolism (intracellular), Plankton (non-specific), Purification & Isolate, Reaction Rates, ...5.0828

Purification & Isolate

ELUCIDATION OF THE METABOLIC PATHWAYS OF MARINE PLANKTONIC ORGANISMS ...Marine Biology (non-specific), Metabolism (intracellular), Organelle-enzyme Assn, Plankton (non-specific), Reaction Rates, ...5.0828

Quantitative & Qualitative

THE EVALUATION OF WHOLESOMENESS OF RADIATION SUB-STERILIZED FOOD PRODUCTS USING RATS ...Animal Protein, Clams, Laboratory Rat, Radiation, Thiaminase, ...6.0031

STUDY OF NITROGEN METABOLISM IN MARINE ALGAE ...Bioindicators, Enzymes, Marine Plants, Microbiological Analysis, Pollution - Effects of, ...5.0727

FORMATION AND METABOLISM OF NEUROHUMORAL TRANSMITTER SUBSTANCES IN MARINE ANIMALS ...Basic Studies, Biochemical, Developmental Stages, Sharks, ...5.0980

Enzymes

Atpase

THE ROLE OF CALCIUM IONS IN THE MOTILITY OF SEA URCHIN AND OTHER SPERMATOZOA ...Calcium, Male Gametes, Motility and Migration, Yellow Perch, Darters, ...5.0622

ION TRANSPORT MECHANISM IN GIANT AXON ...Active Transport, Cell Free Metabolism, Nervous System, Octopus, Squid, Cuttlefish... , Plasma Membrane, ...5.0369

Carbonic Anhydrase

BIOLOGICAL TRANSPORT OF GASES AND OTHER SUBSTANCES ...Active Transport, Carbon Dioxide, Fish, Gases, Kidney and Urinary System, ...5.0240

Cholinesterase

A HISTOCHEMICAL STUDY OF THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Histochemistry - Cytochem, Horseshoe Or King Crabs, Nervous System, Organelle-enzyme Assn, ...5.1000

BIOCHEMICAL CHARACTERIZATION OF CHOLINESTERASES IN THE BLOOD ANDCENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Blood and Lymph, Enzyme-substrate, Horseshoe Or King Crabs, Nervous System, Reaction Rates, ...5.0468

Coenzyme Q

EFFECT OF LIPIDS ON STABILITY OF BIOLOGICAL MEMBRANES ...Cellular Membranes (non-spec.), Electron Microscopy, Stability, Tocopherol, Vitamin A, ...5.1007

Cytochromes

STUDIES OF PROTEINS UNDER EXTREME ENVIRONMENTS ...Cellular Membranes (non-spec.), Exobiology, Halobacteria, Respiration, Salt, ...5.0941

DNA Polymerase

PRESENCE OF ENZYMES RELATED TO DNA SYNTHESIS IN EGGS OF ECHINODERMS ...Basic Embryology, Developmental Stages, Enzyme Formation, Nucleoside Kinase, Sea Urchins & Other Echinoderm, ...5.1034

Dopa Decarboxylase

BIOSYNTHESIS OF 3-HYDROXYTYRAMINE IN MONOSTROMA FUSCUM ...Biosynthesis, Chlorophyceae (non-specif.&ot), Marine Plants, Tyramine, Tyrosinase, ...5.0720

Enzyme Inhibitors

STUDY OF THIAMINASE IN HAWAII FISH ...Enzymatic, Fish - non-specific, Hawaii, Thiaminase, Toxicological and Allergy, ...5.0260

Enzymes -non-specific

BIOCHEMISTRY AND PHYSIOLOGICAL ECOLOGY OF POISONED FISH ...Fish -non-specific, Metabolism, Muscle, Pathology, Toxins -non-specific, ...5.0305

ENZYME STRUCTURE AND ITS RELATION TO TAXONOMY ...Animal Taxonomy, Conformational Studies, Echinodermata -other, Species, ...5.0654

Extracellular-enzymes

MICROBES AND CORROSION ...Cathodic Protection, Fouling, Iron, Metals -non-specific, Microorganisms (non-specific), Respiration, ...8.0228

Luciferase

MECHANISM STUDIES ON BIOLUMENESCENT REACTIONS WITH EMPHASIS ON ENERGY TRANSFER PROBLEMS ...Bioluminescence, Energy Conversion, Luciferin, ...1.0164

Microorganism Enzymes

RESEARCH ON THE ROLE OF BACTERIA IN THE OCEAN ...Denitrification, Elect Trans and Redox, Marine Bacteria, Nitrogen Bacteria, Respiration, ...5.0783

Nucleoside Kinase

PRESENCE OF ENZYMES RELATED TO DNA SYNTHESIS IN EGGS OF ECHINODERMS ...Basic Embryology, Developmental Stages, DNA Polymerase, Enzyme Formation, Sea Urchins & Other Echinoderm, ...5.1034

Plant Enzymes

LIGHT RECEPTOR CONTROL OF THE DIURAL RHYTHM OF ENZYME SYNTHESIS IN THE BIOLUMINOSCENT MARINE DINOFLAGELLATE GONYAULAX POLYEDRA ...Biological Rhythms, Biosynthesis, Control and Regulation, Gonyaulax, Photoreception, ...5.0760

Proteolytic Enzymes

MARINE BACTERIAL ENZYMES ...Cell. env.(non-specific & Ot.), Growth (non-specific & Ot.), Isolation From Nat. environ. , Marine Bacteria, Plant Distr. (non-specific), ...5.0824

Renin

RENIN AND EURYHALINITY ...Comparative Physiology, Histochemistry - Cytochem, Kidney and Urinary System, Osmoregulation, Vertebrates -non-specific, ...5.0973

Ribonuclease

INTERACTION OF PROTEINS WITH METAL AND HYDROGEN IONS ...Globin -incl. myoglobin, Inhibitors, Metallic Ions, Neurophysin, Photochemistry, ...5.0999

Thiaminase

THE EVALUATION OF WHOLESOMENESS OF RADIATION SUB-STERILIZED FOOD PRODUCTS USING RATS ...Animal Protein, Clams, Laboratory Rat, Quantitative & Qualitative, Radiation, ...6.0031

STUDY OF THIAMINASE IN HAWAII FISH ...Enzymatic, Enzyme Inhibitors, Fish -non-specific, Hawaii, Toxicological and Allergy, ...5.0260

UTILIZATION OF FRESHWATER FISH FOR ANIMAL FOODS ...Fish & Shellfish, Fish Meals, Heating, Steaming, Sea Lions, Fur Seals, ...5.0989

Tryptophan Oxidase

BIOCHEMISTRY OF DEVELOPMENT ...Basic Embryology, Control and Regulation, Differentiation Mechanism, Messenger RNA , Sea Urchins & Other Echinoderm, ...5.0994

Tyrosinase

BIOSYNTHESIS OF 3-HYDROXYTYRAMINE IN MONOSTROMA FUSCUM ...Biosynthesis, Chlorophyceae (non-specif.&ot), Dopa Decarboxylase, Marine Plants, Tyramine, ...5.0720

Epidemiology of Disease

Environmental Health

Food (epidemiology)

EFFECTS OF INGESTION OF RADIOACTIVE FISH AND THE NATURE AND BIOLOGY OF TOXINS IN CERTAIN FISHES ...Fish -non-specific, Food Chains, Radioactive Isotopes, Toxicological and Allergy, ...6.0108

OUTGROWTH OF CLOSTRIDIUM BOTULINUM TYPE E IN NONIRRADIATED AND IRRADIATED FISHERY PRODUCTS ...Clostridium Botulinum, Fish -non-specific, Microbiological, Radiation, Refrigeration, ...6.0081

GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE 34 TO 50 F. ...Clostridium Botulinum, Haddock, Microbiological, Radiation, Temperature Control, ...6.0022

DISTRIBUTION OF C. BOTULINUM IN COMMERCIAL SMOKED FISH ...Bacterial Pollutant Sources, Clostridium Botulinum, Fish -non-specific, Microbiological, Smoking, ...5.0337

THERMAL DESTRUCTION OF TYPE E CLOSTRIDIUM BOTULINUM ...Clostridium Botulinum, Differentiation Mechanism, Heat Resistance, Microbiological, Spore Studies, ...6.0006

PROGRAM PROJECT - FOOD MICROBIOLOGY ...Clostridia (non-specific & Ot), Infection, Intoxication & Pois, Microbiological, Salmonella (non-specific & Ot), Toxicological and Allergy, ...6.0005

ANAEROBIC BACTERIA IN THE MARINE ENVIRONMENT ...Fish -non-specific, Isolation From Nat. environ. , Microbiological, ...5.0846

STUDIES ON VIBRIO FOOD POISONING ...Bacteria, Bacterial Endotoxins, Microbiological, Toxicological and Allergy, Vasomotor, ...6.0114

Occupational Hazards

DIVING MEDICINE ...Diffusion of Gases, Divers, Diving and Scuba, Pressure, ...8.0017

SUBMARINE MEDICINE ...Life-support-system, Naval Personnel, Ordnance, Safety, ...8.0018

Mechanism of Transmission

ASPECTS OF RELATIONSHIPS BETWEEN MARINE ECOLOGY AND HUMAN HEALTH ...Environmental Ecology, Marine Biology (non-specific), Public Health Ecology, Toxic Substances -non-specific, ...6.0182

Epizootiology

PATHOLOGY - EPIZOOTIOLOGY ...Mortality Rates, Oysters, Pathology, Protozoa, Protozoa -other, ...5.0441

Control and Prevention

STUDIES ON THE DEVELOPMENT OF DERMOCYSTIDIUM MARINUM ...Cell Cycle, Dermocystidium, Fungal Culture, Oysters, Pathology, ...5.0836

Incidence and Prevalence

Epizootic

EPIDEMIOLOGY OF SALMON POISONING DISEASE ...Helminths, Infectious Conditions and Dis, Pathology, Salmon & Trout - Non-specific, Water Salinity, ...5.0306

EPIZOOTICS IN EXPERIMENTAL MARINE SHELLFISH POPULATIONS ...Freshwater Mussels, Scallops, Mortality Rates, Oysters, Pathology, ...5.0520

Mode of Transmission

INFECTIOUS DISEASES OF SALMONID FISHES ...Bacteria (non-specific), Infectious Conditions and Dis, Pathology, Protozoa -other, Salmon & Trout - Non-specific, ...5.0302

Invertebrates

NATURAL HISTORY OF SALMON POISONING RICKETTSIAE ...Flukes, Helminths, Neorickettsiae Helmint, Reservoirs, ...5.0842

Equipment Purchase Operation

STUDIES ON THE PHYSIOLOGY OF MARINE ORGANISMS USING RADIOISOTOPES ...Facilities, Marine Plants, Radioisotopes -non-specific, ...12.0031

SUPPORT OF RESEARCH VESSEL VELERO 4 ...California, Facilities, Geology-general, Instrumentation-general, Marine Biology, Training Grants, Fellowships, ...4.0115

SUPPORT OF THE RESEARCH VESSEL AHOYOHA III ...California, Diving and Scuba, Geology-general, Marine Biology, Ships and Cruises, ...12.0008

X-RADIOGRAPHIC AND ELECTRONIC FLUOROSCOPIC EQUIPMENT ...Core Analysis, Instrumental Services, Radiograph, Radiometer, X Ray Tubes, ...8.0094

LENGTHENING AND INCREASING OCEANOGRAPHIC CAPABILITES OF R/V ACONA ...Modification-conversion, Oceanography-general, Pacific Ocean-north, Shoreline - Coastline, Special Mission Ships, ...12.0002

RESEARCH VESSEL U.S.N.S ELTANIN ...Antarctica, Geophysics-general, Scientific-service-support, Special Mission Ships, Teaching and Research, ...12.0036

ROCK SAMPLING AND GEOPHYSICAL STUDIES IN THE TONGA KERMADEC TRENCH SOUTHWEST PACIFIC ...American Samoa, Coring and Dredging, Pacific Ocean-west, Photography, Seismic Reflection, Trenches, ...7.0093

RARE GAS STUDY OF INTERPLANETARY MATERIAL IN PELAGIC SEDIMENTS ...Chemistry, Cosmogenous, Element Ratios, Mass Spectroscopy, Mineralogy, X-ray, ...7.0081

OCEANOGRAPHIC VESSEL OPERATIONS ...Geology-general, Pacific Ocean-north, Plankton (non-specific), Plant Prod. (non-specific), Ships and Cruises, ...12.0047

COOPERATIVE SYSTEMATICS STUDIES IN ANTARCTIC BIOLOGY ...Animal Taxonomy, Antarctica, Cooperative-studies, Invertebrates -non-specific, ...5.0581

SHIPBOARD GRAVITY SENSOR AND GYROCOMPASS ...Geophysical Equipment, Gryo, Scientific-service-support, ...8.0103

SPECIALIZED RESEARCH EQUIPMENT FOR SEA ICE STUDIES ...Alteration, Sea Ice, ...3.0086

UNDERWATER CAMERA SYSTEM ...Pacific Ocean-north, Photography, Sediments-general, Structural Studies, ...8.0154

AQUISITION OF A SUITABLE PROTOTYPE FISHING VESSEL AND GEAR ...American Samoa, Commercial Fishing, Nets, Tuna, Mackerel, Albacore... , ...12.0004

PURCHASE OF MATERIALS FOR & CONSTRUCTION OF, FLOATS, RACKS, BAGS, AND TRAYS FOR THE SUSPENSION OF VARIOUS TYPES OF CULTCH ...Biological Rhythms, Derivatives, Oysters, Spawning & Nesting Sites, Stocking of Fish & Shellfish, ...8.0008

SUPPORT OF THE MARINE BIOLOGY PROGRAM AT THE LAMONT GEOLOGICAL OBSERVATORY ...Marine Biology, New York, ...11.0033

RESEARCH FLIGHT FACILITY ...Aircraft, General Synoptic Observations, Technique Development, Tropical Cyclones, ...4.0158

Erosion Control

Wind Erosion

MESO WIND PATTERNS IN THE CENTRAL CALIFORNIA VALLEY ...Atmospheric Pollution-general, California, Drift (pesticide), Herbicides -non-specific, Land-sea Breezes, ...3.0056

Erosion-general

HYDRAULICS AND DYNAMICS OF ESTUARIES ...Estuaries, Flow Characteristics -water, Sedimentation, Sedimentology-general, Water Level Fluctuation, Waves, ...7.0102

Estuaries

(A) ANNUAL SUPPLY OF PARTICULATE MATTER IN THE GREAT BAY ESTUARY (B) LATE PLEISTOCENE HISTORY OF THE GREAT ...New Hampshire, Organics, Quaternary Period, Sampling, Sedimentary History, ...1.0155

APOLLO TEST SITE EXPERIMENT ...Aircraft, Hydraulics-general, Hydrology-general, Recognition Systems, Remote Sensing-general, ...4.0146

THE ACCUMULATION OF FISSION PRODUCTS BY MARINE FISH AND SHELLFISH ...Chlorideae (non-specific & Ot), Contamination - Water, Food Chains, Radioactivity-general, Radioecology, ...6.0167

THE BIOLOGY AND CHEMISTRY OF TRACE ELEMENTS IN MARINE AND ESTUARINE WATERS ...Chesapeake Bay, Phytoplankton, Productivity - Food Chain, Trace Element Analysis, Zooplankton, ...5.0975

MOVEMENT OF RADIONUCLIDES IN THE COLUMBIA RIVER ESTUARY ...Columbia River, Discharge, Radioactivity, Salinity, Sediment Transport-other, ...6.0179

OCEAN KINEMATICS DYNAMICS ...Chesapeake Bay, Circulation-general, Data Reduction and Analysis, Turbulent Flow, Water Motion, ...2.0069

TURBULENT DIFFUSION STUDY ...Chesapeake Bay, Dispersion -water, Tracers-general, Turbulent Flow, Water Motion, ...2.0056

ESTUARINE SEDIMENTATION PROCESSES ...General Deposition, Intertidal Areas, Morphology-general, New England Province, Tidal Streams, Tides, ...7.0244

CONTROLLED ENVIRONMENTAL FACTORS ON THE DEVELOPMENT OF ESTUARINE AND OCEANIC CRUSTACEA ...Aquatic Ecology, Crabs, Developmental Physiology, Salinity, Temperature, ...5.0476

ECOLOGICAL AND EVOLUTIONARY IMPLICATIONS OF THE ECOTYPES OF ESTUARINE CRUSTACEA ...Classical, Invertebrate Anatomy, Isopods, Metabolism, Productivity - Food Chain, ...5.0418

TEMPERATURE AND SALINITY TOLERANCE OF THE SAND SHRIMP, CRANGON SEPTEMSPINSOA ...Environment Resistance, Environmental Physiology, Salinity, Shrimps - Common, Temperature, ...5.0437

SUPPORT OF UNIVERSITY OF GEORGIA MARINE INSTITUTE RESEARCH VESSEL OPERATION ...Continental Shelf, Continental Slope, Distribution, Environmental Ecology, Geomorphology-topography, Marine Biology, Pollution Sources-general, Ships and Cruises, Textures-structures, ...12.0026

TROPHIC RELATIONSHIPS IN SHOAL BENTHIC ENVIRONMENTS ...Benthic Flora, Biology, Habitat Studies, New England Province, ...5.1027

ECOLOGICAL STUDY OF CHARLOTTE HARBOR ESTUARY AND SHARK PROGRAM OF MOTE MARINE LAB ...Florida, Mans Activities, Sharks, ...5.0884

OPTIMUM ECOLOGICAL DESIGNS FOR ESTUARINE SYSTEMS OF NORTH CAROLINA ...Domestic Wastes-general, Marine Biology (non-specific), North Carolina, Pollution - Effects of , Pollution Effects, Productivity - Food Chain, ...5.0913

ESTUARINE SEDIMENTARY MODELS ...Circulation-general, Distribution, Grain Size, Model Studies, Textures-structures, ...4.0079

THE INSTITUTE FOR THE DEVELOPMENT OF RIVERINE AND ESTUARINE SYSTEMS (IDRES) ...Delaware River, Waste Disposal-general, ...12.0043

FIORD OCEANOGRAPHY ...Alaska, Fjords, Hydrodynamics, Model Studies, Simulation Theory, ...4.0040

SEA WATER OPTICS STUDIES ...Optical, Size Frequency Distribution, Suspension, ...1.0166

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...Aquatic Ecology, Mans Activities, Persistance of Residues, Pesticides -non-specific, Pollution - Effects of , Population Dynamics, Standing Crops, ...5.0880

ESTUARINE DREDGE HOLE INVESTIGATIONS ...Aquatic Ecology, Coring and Dredging, Fish -non-specific, Habitat Studies, ...5.0908

A STUDY OF THE ICHTHYOPLANKTON ASSOCIATED WITH TWO OF NEW JERSEYS COASTAL INLETS ...Nets, Salinity, Thermal, Water Salinity, Water Temperature-non-specific, Zooplankton, ...5.0806

TRAMMEL NET SAMPLING IN ESTUARINE AREAS ...Competition, Fish -non-specific, Lakes, Nets, Population Dynamics, ...5.0096

QUANTITATIVE AND QUALITATIVE MEASUREMENT OF AQUATIC VEGETATION-CURRITUCK SOUND ...Aquatic Plants (non-specific), Range Or Territorial Distr. , Saline Water Intrusion, Salinity, Vertical Distribution, ...5.0717

CHARTING OF SUBTIDAL OYSTER BEDS AND EXPERIMENTAL TRANSPLANTING OF SEED OYSTERS FROM POLLUTED SEED OYSTER BEDS ...Captive Rearing, Commercial Fishing, Oysters, South Carolina, Stocking of Fish & Shellfish, ...8.0011

SURVEY OF A POTENTIAL HARD CLAM FISHERY ...Clams, Commercial Fishing, Coring and Dredging, Georgia, Spawning & Nesting Sites, ...5.0420

A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY ...Commercial Fishing, Mans Activities, Pollution - Effects of , Spawning & Nesting Sites, Texas, ...5.0926

CHANGES DURING EUTROPHICATION OF AN ESTUARY ...Eutrophication, North Carolina, Plankton (non-specific), Pollution - Effects of , ...5.0915

ESTUARINE WATER QUALITY AND FISH DISTRIBUTION ...Contamination - Water, Environmental Physiology, Pollution Effects, Pulp, Paper , and Logging, Salmon & Trout - Non-specific, ...5.0178

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SPECTRAL SIGNATURES OF FISH SCHOOL IDENTIFICATION ...Atomic Absorption, Fish -non-specific, Oil, Spectral Reflectance, ...4.0151

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PROCESSING KING CRAB ...Commercial Fishing, Crabs, Fish & Shellfish, Freezing, Organoleptic Studies, ...6.0003

DEVELOPMENT OF MECHANIZATION DEVICE PROTOTYPES ...Design, Machinery, Equipment, Fish Protein Concentrate, Shrimp, ...6.0051

UTILIZATION OF FRESHWATER FISH FOR ANIMAL FOODS ...Fish & Shellfish, Heating, Steaming, Sea Lions, Fur Seals, Thiaminase, ...5.0989

BOTTOM FISH, FISH WASTE, SCRAP FISH & OTHER SEA PRODUCTS FOR FUR ANIMAL DIETS ...Alewife,menhaden,shad,herring, Antioxidants, Chubs, Notropis, Management, Sea Lions, Fur Seals, ...6.0001

Processing and Preservation

Heating, Steaming

UTILIZATION OF FRESHWATER FISH FOR ANIMAL FOODS ...Fish & Shellfish, Fish Meals, Sea Lions, Fur Seals, Thiaminase, ...5.0989

Purified Diets

NUTRITION OF SALMONID FISHES ...Captive Rearing, Diet Or Ration -other, in Vivo--see Also Feed Rations, Salmon & Trout - Non-specific, ...5.0304

Quality Evaluation of Feed

in Vivo--see Also Feed Rations

NUTRITION OF SALMONID FISHES ...Captive Rearing, Diet Or Ration -other, Purified Diets, Salmon & Trout - Non-specific, ...5.0304

Rations

Cattle Rations -other

MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY ...Commercial Fishing, Fish & Shellfish, Fish Meals, Market Structure, Marketing, Poultry Rations -other, ...4.0177

Poultry Rations -other

MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY ...Cattle Rations -other, Commercial Fishing, Fish & Shellfish, Fish Meals, Market Structure, Marketing, ...4.0177

Supplements, Feed Additives

Antioxidants

BOTTOM FISH, FISH WASTE, SCRAP FISH & OTHER SEA PRODUCTS FOR FUR ANIMAL DIETS ...Alewife,menhaden,shad,herring, Chubs, Notropis, Fish Meals, Management, Sea Lions, Fur Seals, ...6.0001

Ferrous Alloys

Low Alloy Steels

EFFECTS OF MATERIAL VARIATIONS IN THE COMPUTERIZED DESIGN OF PRIMARY HULL STRUCTURE ...Bulkheads, Computer Applications, Engineering Studies-other, Materials Used Undersea, Strength, Cohesion, ...8.0298

WEIGHT ANALYSIS IN FISHING BOATS ...Approximations, Hull, Measuring Devices-other, Pressure Effects, ...8.0295

STEEL PILING ...Corrosion Prevention-other, Fouling, Polarization, Soils, Water, ...8.0208

CORROSION MITIGATION ...Corrosion Prevention-other, Deep, Fouling, Pre-stressed, Water, ...8.0205

High Yield

HY 130-150 STRUCTURAL STEELS ...Low Alloy Steels - Other, Materials Used Undersea, Stress Concentration-toughness, Stress Corrosion, Welding - Other, ...8.0221

HY 80-110 STRUCTURAL STEELS ...Materials Used Undersea, Stress Concentration-toughness, Welding - Other, ...8.0222

HY 180/210 STRUCTURAL STEELS ...Low Alloy Steels - Other, Maraging, Materials Used Undersea, Precipitation Hardening, Stress Concentration-toughness, Welding - Other, ...8.0224

Low Alloy Steels - Other

HY 130-150 STRUCTURAL STEELS ...High Yield, Materials Used Undersea, Stress Concentration-toughness, Stress Corrosion, Welding - Other, ...8.0221

HY 180/210 STRUCTURAL STEELS ...High Yield, Maraging, Materials Used Undersea, Precipitation Hardening, Stress Concentration-toughness, Welding - Other, ...8.0224

Stainless Steels

Maraging

HY 180/210 STRUCTURAL STEELS ...High Yield, Low Alloy Steels - Other, Materials Used Undersea, Precipitation Hardening, Stress Concentration-toughness, Welding - Other, ...8.0224

Precipitation Hardening

HY 180/210 STRUCTURAL STEELS ...High Yield, Low Alloy Steels - Other, Maraging, Materials Used Undersea, Stress Concentration-toughness, Welding - Other, ...8.0224

Fiber, Filament

PRODUCTION OF PLATES OF FIBER COMPOSITES BY SOLIDIFICATION, FORMING AND A COMBINATION OF BOTH ...Aluminum, Intermetallic Compound, Metal Matrix, Nickel, Orientation, ...8.0230

STRUCTURAL PLASTICS-DEEP SUBMERGENCE ...Design Data, Epoxies, Glass, Materials Used Undersea, Plastic Matrix, ...8.0213

Fire Control

SONAR ACCURACY ...Acoustic, Acoustical, Instrumental Services, Platforms, Sonar, Transmission, ...1.0051

Fish

Alewife,menhaden,shad,he ring

TAXONOMY AND DISTRIBUTION OF CLUPEOIDS AND REVISION OF THE GENUS ILISHA OF THE FAMILY CLUPEIDAE ...Animal Taxonomy, Handbooks, Indian Ocean-general, Nomenclature, Classification, Range Or Territorial Distr. , ...5.0088

POTENTIAL FISHERY FOR RIVER HERRINGS IN CONNECTICUT RIVER ...Connecticut River, Data Acquisition, Life History Studies, Nets, Spawning & Nesting Sites, Survey Studies, ...5.0202

BIOLOGY OF ANADROMOUS ALOSIDS ...Mortality Rates, Spawning & Nesting Sites, Streams, Tidal Streams, Virginia, ...5.0150

A STUDY OF THE RATE AND PATTERN OF SHAD MIGRATION IN THE CONNECTICUT RIVER UTILIZING SONIC TRACKING APPARATUS ...Connecticut River, Migration, Spawning & Nesting Sites, Tags, Telemetry, ...5.0046

ANADROMOUS FISHERY ...Censusing, Commercial Fishing, Massachusetts, ...4.0011

STUDY OF THE RIVER PHASE OF THE LIFE HISTORIES OF ALOSA PSEUDOHARENGUS AND AESTIVALIS ...Aquatic Ecology, Connecticut River, Life History Studies, Spawning & Nesting Sites, ...5.0245

FARMINGTON RIVER SHAD STUDIES ...Bottom Sampling, Captive Rearing, Migration, Sampling, Streams, ...5.0203

EFFECTS OF MARSH MANAGEMENT STRUCTURES UPON FISHES ...Crabs, Engineering Structures-general, Land Use, Shrimps - Common, Spawning & Nesting Sites, Swamps-marshes, ...5.0206

INVESTIGATION OF COMMERCIAL FISH POPULATIONS IN WESTERN LAKE SUPERIOR ...Commercial Fishing, Lake Superior, Lakes, Nets, Population Dynamics, ...5.0113

LIFE HISTORY OF CLUPEA HARENGUS PALLASI ...Aquaculture & Fish-farming, Artifical Insemination, Life History Studies, Water Salinity, Water Temperature-non-specific, ...5.0035

ABUNDANCE AND AVAILABILITY OF PRE-RECRUIT HERRING ...Aquatic Ecology, Environmental Ecology, Life History Studies, Number Or Density, Vertical Distribution, ...5.0208

RACIAL STUDIES OF HERRING ...Animal Taxonomy, Atlantic Ocean-north, Biochemical Analysis, Blood Typing Studies, Management -other, ...5.0265

BIOSTATISTICS OF HERRING ...Age, Atlantic Ocean-north, Environmental Ecology, Growth Rate, Population Dynamics, Proprioceptors, ...5.0099

COLLECTION, COMPILATION, AND ANALYSIS OF GULF CATCH STATISTICS AND LOGBOOK DATA ...Commercial Fishing, Computer Methods -general, Fish Studies -other, ...5.0126

INVESTIGATION OF THE BIOLOGY AND POPULATION STRUCTURE OF GULF MENHADEN ...Bone, Gulf of Mexico, Handbooks, Population Dynamics, Vertebrate Anatomy, ...5.0128

ESTIMATION OF JUVENILE ABUNDANCE IN ESTUARINE NURSERIES ...Aquatic Ecology, Estuaries, Gulf of Mexico, Maturity & Growth Stages, Number Or Density, ...5.0131

SAMPLING OF THE ATLANTIC COMMERCIAL CATCH ...Atlantic Ocean-general, Commercial Fishing, Nets, Number Or Density, ...5.0129

POPULATION STUDIES ...Animal Distr. (non-specific), Animal Taxonomy, Environmental Ecology, Population Dynamics, ...5.0130

ESTUARINE BIOLOGY--RESPONSE OF LARVAE TO TEMPERATURE AND SALINITY ...Captive Rearing, Estuaries, Longevity, Low Temp. -but Above 32f, Maturity & Growth Stages, Water Salinity, ...5.0213

TAGGING ...Migration, Population Dynamics, Tags, Telemetry, Vertebrate Anatomy, ...5.0127

MARINE BIOLOGICAL INVESTIGATIONS - ANALYSIS OF HERRING FISHERY DATA ...Age, Alaska, Data Analysis - General, Dispersion -other, ...5.0010

POPULATION STRUCTURE OF THE ALEWIFE AND COREGONIDS ...Aquatic Ecology, Cisco, Lake Herring, Environmental Ecology, Lake Michigan, Population Dynamics, ...5.0106

INTERRELATIONS OF ALEWIVES AND ASSOCIATED SPECIES ...Behavioral Ecology, Competition, Lake Michigan, Predation, Vertical Distribution, ...5.0111

TAXONOMY AND BIOLOGY OF CLUPEOID FISHES ...Anchovies, Animal Taxonomy, Atlantic Ocean-general, Handbooks, ...5.0060

SCHOOLING BEHAVIOR ...Anchovies, Behavioral Ecology, Environmental Ecology, Tuna, Mackerel, Albacore... , ...5.0038

FEEDING BEHAVIOR ...Anchovies, Behavior, Environmental Physiology, Food Supply, Sensory Organs, ...5.0040

REARING MARINE FISH ...Anchovies, Captive Rearing, Environmental Physiology, Tuna, Mackerel, Albacore... , ...5.0041

BOTTOM FISH, FISH WASTE, SCRAP FISH & OTHER SEA PRODUCTS FOR FUR ANIMAL DIETS ...Antioxidants, Chubs, Notropis, Fish Meals, Management, Sea Lions, Fur Seals, ...6.0001

Anchovies

TAXONOMY AND BIOLOGY OF CLUPEOID FISHES ...Alewife,menhaden,shad,herring, Animal Taxonomy, Atlantic Ocean-general, Handbooks, ...5.0060

DETERMINE ALTERNATE LIVEBAIT SPECIES ...Captive Rearing, Commercial Fishing, Food Supply, Hawaii, Tuna, Mackerel, Albacore... , ...5.0080

SCHOOLING BEHAVIOR ...Alewife,menhaden,shad,herring, Behavioral Ecology, Environmental Ecology, Tuna, Mackerel, Albacore... , ...5.0038

FEEDING BEHAVIOR ...Alewife,menhaden,shad,herring, Behavior, Environmental Physiology, Food Supply, Sensory Organs, ...5.0040

REARING MARINE FISH ...Alewife,menhaden,shad,herring, Captive Rearing, Environmental Physiology, Tuna, Mackerel, Albacore... , ...5.0041

SUBPOPULATIONS ...Commercial Fishing, Pacific Ocean-general, Population Dynamics, ...5.0042

Atlantic Salmon, Sebago Salmon

AQUATIC MYXOBACTERIA - CHONDROCOCCUS COLUMNARIS ...Identification , Myxobacteria, Pathology, Warm Water, ...5.0848

COMPARATIVE BEHAVIOR OF HATCHERY-REARED AND WILD SALMONIDS ...Behavior, Captive Rearing, Environmental Physiology, Lake Trout, Brook Trout, ...5.0264

Basses -sea,white, White Perch

SPORT FISH BEHAVIORAL STUDIES ...Behavioral Ecology, Habitat Studies, Porgies, Rockfish, Scoraionfish, ...5.0045

ESTIMATION OF PARAMETERS OF STRIPED BASS POPULATION AND DESCRIPTION OF THE FISHERY OF LOWER CHESAPEAKE BAY ...Age, Censusing, Chesapeake Bay, Fishing Gear, Population Dynamics, ...5.0151

STOCKING AND SURVIVAL OF STRIPED BASS FINGERLINGS ...Alabama, Commercial Fishing, Maturity & Growth Stages, Stocking of Fish & Shellfish, Streams, ...5.0001

Blue Catfish, White Catfish

CULTURE OF BLUE, CHANNEL, AND WHITE CATFISH IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Brackish Water, Captive Rearing, Channel Catfish, Louisiana, ...8.0006

MOVEMENTS OF FRESHWATER CATFISH IN THE ESTUARIES OF SOUTHWEST LOUISIANA ...Environment Resistance, Estuaries, Louisiana, Migration, Water Salinity, ...5.0090

Bluefish

LOCATION OF INSHORE SPAWNING AREAS ...Long Island Sound, Nets, Spawning & Nesting Sites, Water Temperature-non-specific, ...5.0201

BLOOD TYPES AS INDICATORS OF BLUEFISH RACES ...Blood Cells, Blood Plasma and Serum, Blood Typing Studies, Immunology, Polymorphism, ...5.0319

HEMOGLOBIN VARIATIONS AS INDICATORS OF BLUEFISH RACES ...Animal Taxonomy, Hemoglobin, Polymorphism, Reproduction Studies (general), ...5.0320

RETINAL RHYTHMS UNDER CONTROLLED LIGHT ...Darkness, Histology and Cytology, Light Quantity -non-specific, Visual, Visual Organs, ...5.0282

LIGHT AND DARK ADAPTION IN THE RETINAE OF YOUNG BLUEFISH ...Adaptation, Photoperiod, Retina, Visual Organs, ...5.0283

RELATION OF TEMPERATURE TO RHYTHMIC BEHAVIOR ...Behavior, Biological Rhythms, Environmental Physiology, Locomotion -animal, Low Temp. -but Above 32f, ...5.0284

TRACKING MIGRATIONS OF BLUEFISH POPULATIONS ALONG ATLANTIC COAST TO LEARN BIOLOGY OF THE SPECIES (MIGRATORY HABITS OF BLUEFISH) ...Atlantic Ocean-north, Migration, Population Dynamics, Tags, ...5.0120

INFLUENCE OF UNLIMITED FOOD SUPPLY ON RHYTHMIC ACTIVITY OF BLUEFISH ...Biological Rhythms, Food Supply, Predation, ...5.0122

RHYTHMIC ACTIVITY OF BLUEFISH IN RELATION TO NORMAL LIGHT REGIME ...Biological Rhythms, Environmental Physiology, Locomotion -animal, Photoperiod, ...5.0285

RHYTHMIC ACTIVITY OF BLUEFISH UNDER EXPERIMENTALLY VARIED LIGHT REGIMES ...Adaptation, Biological Rhythms, Environmental Physiology, Photoperiod, Water Light Quality & Quantity, ...5.0286

AGE AND GROWTH OF BLUEFISH ...Age, Atlantic Ocean-north, Growth Rate, Population Dynamics, Scales, ...5.0287

Bluegills, Bream

EXPERIMENTAL AND BIOMATHEMATICAL ANALYSIS OF THE PHENOMENON OF ATTACK ...Behavioral Ecology, Computer Methods -general, Environmental Physiology, Largemouth Bass, Minnows, Predation, ...5.0535

RATE OF ABSORPTION OF ENDRIN BY BLUEGILL SUNFISH ...Bioassay, DDT , Endrin, Metabolism, Mode of Action -animal, ...5.0263

Bonneville Cisco

DEVELOPMENTAL MORPHOLOGY OF COREGONIDS ...Aquatic Ecology, Cisco, Lake Herring, Developmental Physiology, Great Lakes-general, Vertebrate Anatomy, ...5.0274

Bullheads

BEHAVIOR IN EMBRYOS AS IT RELATES TO ENCEPHALIZATION ...Basic Embryology, Behavior, Central Nervous System, Developmental Physiology, Visual Organs, ...5.0270

Channel Catfish

CULTURE OF BLUE, CHANNEL, AND WHITE CATFISH IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Blue Catfish, White Catfish, Brackish Water, Captive Rearing, Louisiana, ...8.0006

Chondrichthyes -other

SYSTEMATICS, ZOOGEOGRAPHY, AND ECOLOGY OF ELASMOBRANCHS OF THE WESTERN ATLANTIC OCEAN ...Animal Taxonomy, Aquatic Ecology, Atlantic Ocean-general, Nearctic, ...5.0132

OSMOTIC COMPONENTS IN ELASMOBRANCH BLOOD ...Blood Plasma and Serum, Environmental Physiology, Osmoregulation, Water Salinity, Water Temperature-non-specific, ...5.0249

Chubs, Notropis

BOTTOM FISH, FISH WASTE, SCRAP FISH & OTHER SEA PRODUCTS FOR FUR ANIMAL DIETS ...Alewife,menhaden,shad,herring, Antioxidants, Fish Meals, Management, Sea Lions, Fur Seals, ...6.0001

Cisco, Lake Herring

DEVELOPMENTAL MORPHOLOGY OF COREGONIDS ...Aquatic Ecology, Bonneville Cisco, Developmental Physiology, Great Lakes-general, Vertebrate Anatomy, ...5.0274

POPULATION STRUCTURE OF THE ALEWIFE AND COREGONIDS ...Alewife,menhaden,shad,herring, Aquatic Ecology, Environmental Ecology, Lake Michigan, Population Dynamics, ...5.0106

EARLY LIFE HISTORY OF COREGONIDS ...Environmental Ecology, Life History Studies, Maturity & Growth Stages, Technique Development, Water Environment -other, ...5.0110

Codfishes, Hake

TAGGING ENGLISH SOLE, PETRALE SOLE, AND PACIFIC COD ...Commercial Fishing, Migration, Righteye Flounders, Size, Tags, Washington, ...5.0158

TAG RECOVERY, ENGLISH SOLE, PETRALE SOLE, AND PACIFIC COD ...Migration, Population Dynamics, Righteye Flounders, Tags, Washington, ...5.0159

SAMPLING OF GROUNDFISH STOCKS ...Age, Bone, Proprioceptors, Righteye Flounders, Size, ...5.0160

PELAGIC FISH EXPLORATIONS ...Commercial Fishing, Fish -other, Nets, Vertical Distribution, ...5.0172

POPULATION DYNAMICS OF NEW ENGLAND GROUNDFISH ...Atlantic Ocean-north, Lefteye Flounders, Population Dynamics, Rockfish, Scoraionfish, ...5.0103

LIFE HISTORY OF THE BURBOT AND LONGNOSE SUCKER ...Lake Superior, Lakes, Life History Studies, Suckers, ...5.0184

BIOLOGICAL STUDIES OF NORTHWEST ATLANTIC GROUNDFISH ...Atlantic Ocean-north, Freshwater Mussels, Scallops, Righteye Flounders, Rockfish, Scoraionfish, ...5.0104

GROUNDFISH INVESTIGATIONS (POTENTIAL YIELD OF UNDERUTILIZED GROUNDFISH STOCKS) ...Commercial Fishing, Legislation, Number Or Density, Rockfish, Scoraionfish, ...5.0171

BLOOD PARASITES OF NORTHWEST FISHES ...Blood Plasma and Serum, Helminths, Protozoa, Sculpins, Trematoda -other, ...5.0335

Cutthroat Trout

MECHANISMS OF HOMING AND ORIENTATION OF SALMO CLARKI IN YELLOWSTONE LAKE AND ITS TRIBUTARIES ...Aquatic Ecology, Behavior, Biological Rhythms, Wyoming, ...5.0279

Deepsea Smelts

TAXONOMIC REVISION OF BATHYLAGIDAE ...Animal Taxonomy, Tables, Compilations, Catalogs, Temperate, Tropic, ...5.0055

Drums

COMPARATIVE BIOCHEMISTRY OF PROTEINS FROM GULF FISH ...Blood Proteins -non-specific, Gel Electrophoresis, Hemoglobin, Shrimps - Common, ...5.0326

CULTURE OF ATLANTIC CROAKER IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Brackish Water, Captive Rearing, Management, Ponds, Productivity (agricultural), ...8.0005

DISTRIBUTION, AGE GROWTH, AND MORTALITY STUDIES OF SALT WATER FISHES OF IMPORTANCE TO SPORT FISHERMEN ...Age, Chesapeake Bay, Growth Rate, Mortality Rates, Vertical Distribution, ...5.0155

DIURNAL-NOCTURNAL ACTIVITY OF THE QUEENFISH, SERIPHUS POLITUS ...Aquatic Ecology, Behavioral Ecology, Biological Rhythms, Fish -other, Other, Sound Production, ...5.0230

Fish -non-specific

FISHERIES RESOURCES IDENTIFICATION AND ASSESSMENT ...Aerial Photography, Behavioral Ecology, Commercial Fishing, Optical, Spectral Reflectance, ...4.0149

SPECTRAL SIGNATURES OF FISH SCHOOL IDENTIFICATION ...Atomic Absorption, Oil, Oils -fats, Spectral Reflectance, ...4.0151

REMOTE SENSOR SYSTEMS INTERGRATION AND PRESENT OPERATIONS DESCRIPTION ...Commercial Fishing, Remote Sensing -other, Spacecraft Sensory Devices, Spectral Reflectance, ...4.0154

SIMULATED WEIGHTLESSNESS IN FISH ...Behavior, Cardiovascular System, Gravitational Fields, Gravity, Proprioceptors, ...5.0275

DETECTION AND CLASSIFICATION OF FISH AND MINERAL OIL SLICKS BY REMOTE SENSING FROM ORBITAL ALTITUDE ...Oil, Oils -fats, Spectral Reflectance, Ultra - Violet Radiation, ...4.0140

A STUDY OF THE DEEP CIRCULATION AND DEEP FISH POPULATIONS IN THE PACIFIC OCEAN ...Currents-ocean, Pacific Ocean-general, Tides, Vertical Distribution, ...2.0005

IONOCYTE FORMATION IN GILL EPITHELIUM OF FISHES ...Biosynthesis, Developmental Physiology, Differentiation Mechanism, Fish, Osmoregulation, ...5.0301

COMPARATIVE STUDY OF NITROGEN SECRETION IN FISHES ...Comparative Physiology, Fish, Metabolism, Nitrogen, Vertebrate Anatomy, ...5.1022

SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES ...Behavior, Environmental Physiology, Migration, Orientation, Sensory Organs, ...5.0338

COPEPOD CRUSTACEANS PARASITIC ON FISHES ...Collections, Copepods, Ectoparasites, Indian Ocean-general, Ships and Cruises, Vertical Distribution, ...5.0368

STRUCTURE OF THE FISH FAUNA OF A FLORIDA CORAL REEF ...Ecological, Reefs, Vertical Distribution, ...5.0205

STUDIES IN THE PHYSIOLOGY AND BIOCHEMISTRY OF DEEP-SEA FISHES ...Environmental Physiology, Metabolism, Vertical Distribution, Water Pressure, ...5.0237

MARINE ZOOGEOGRAPHY ...Tables, Compilations, Catalogs, ...5.0593

ICHTHYOFAUNA OF THE FLORIDA CURRENT ...Florida, Number Or Density, Temporal Distribution, Vertical Distribution, ...5.0066

BIOLOGICAL ASPECTS OF MIDWATER SOUND SCATTERING ...Atlantic Ocean-north, Bioluminescence, Range Or Territorial Distr. , Scattering, Sound Production, Vertical Distribution, ...1.0054

SHORE FISHES OF ANNOBON AND FERNANDO POO ...Art Work-illustrations-etc, Atlantic Ocean-general, Collections, Museum, ...5.0067

RENEWAL RESEARCH PROPOSAL FOR HEARING AND ALLIED SENSES IN FISHES ...Auditory, Behavior, Sound Production, ...5.0254

MORPHOGENETIC MOVEMENTS IN FISH EMBRYOS ...Basic Embryology, Morphological Action, ...5.0281

NUTRITION AND PHYSIOLOGY OF MARINE FISH IN CONTROLLED GNOTOBIOTIC ENVIRONMENTS ...Aquaria, Environmental Phyziology, Germ Free Animal, Nutrition -other, ...5.0317

OCEANIC FISHES OF THE TROPICAL ATLANTIC ...Atlantic Ocean-south, Survey Studies, Tropic, Vertical Distribution, ...5.0068

FACTORS AFFECTING HORIZONTAL DISTRIBUTION OF MESOPELAGIC FISHES ...Aquatic Ecology, Atlantic Ocean-north, Behavioral Ecology, Range Or Territorial Distr. , Vertical Distribution, ...5.0105

ACOUSTICO-LATERALS FUNCTION IN FISH ORIENTATION AND COMMUNICATION ...Auditory, Behavior, Orientation, Sensory Organs, Signal Detection, ...5.0289

SCHOOLING BEHAVIOR IN FISHES ...Behavior, Sensory Organs, Social Behavior, Visual Organs, ...5.0125

PARASITISM IN DEEPSEA FISHES ...Helminths, Host Specificity, Protozoa, Vertical Distribution, ...5.0243

DISTRIBUTION OF THE MID-WATER FISHES OF THE GULF OF CALIFORNIA ...Environmental Ecology, Gulf of California, Nets, Organism Sampling Devices, Vertical Distribution, ...5.0043

LIPID COMPOSITION OF ANTARCTIC MARINE ORGANISMS AND SEA WATER ...Antarctic Ocean, Gulf of Mexico, Lipids, Low Temp. -but Above 32f, Phytoplankton, Productivity - Food Chain, Zooplankton, ...5.1031

THE EFFECTS OF SEAL AND FISH PREDATION ON CERTAIN ANTARCTIC BENTHIC COMMUNITIES ...Antarctica, Benthic Organisms (non-specif), Biology, Predation, Productivity - Food Chain, Seals, ...5.1039

THERMALMETABOLIC RELATIONSHIPS OF STENOTHERMAL FISHES ...Antarctica, Environmental Physiology, Proprioceptors, Thermonegulation, Water Pressure, Water Temperature-non-specific, ...5.0312

CONFERENCE ON THE FUTURE OF THE U.S. FISHING INDUSTRY ...Commercial Fishing, Meetings, ...4.0188

THE STATUS AND POTENTIAL OF AQUACULTURE ...Algal Culture, Aquaculture & Fish-farming, Food Supply, Survey Studies, ...8.0003

SONIC SENSITIVITY OF FISHES AND AMPHIBIA ...Auditory, Comparative Physiology, Frogs, Sensory Organs, ...5.0960

DEEP-WATER FOULING ...Biological, Fouling, Predation, Vertical Distribution, ...8.0233

VENOMOUS FISHES AND SEA SNAKES OF SOUTHEAST ASIA ...Behavior, Snakes, Southeast Asia, Venom, Vertebrate Anatomy, ...6.0101

CRYOGENIC PRESERVATION OF VIABLE FISH SPERM ...Artifical Insemination, Cellular Physiology, Freezing Techniques, Male Gametes, ...5.0303

ECOLOGICAL INVESTIGATIONS OF SOME COMMON MARINE FISHES OFF THE MEDITERRANEAN COAST OF ISRAEL ...Mediterranean Sea-general, Population Dynamics, Productivity - Food Chain, Range Or Territorial Distr. , ...5.0089

SEA SLED AND SCUBA RECONNAISSANCE OF INSHORE AND STUDIES ON EFFECT OF ARTIFICIAL SHELTERS ON STANDING CROP OF FISHES ...Coastlines-shorelines, Diving and Scuba, Geomorphology-topography, Hawaii, Management -other, ...9.0008

ESTUARINE DREDGE HOLE INVESTIGATIONS ...Aquatic Ecology, Coring and Dredging, Estuaries, Habitat Studies, ...5.0908

CHEMICAL AND PHYSICAL DATA ...Population Dynamics, Temperature, Turbidity & Suspended Matter, Water Movement, Currents,, Water Salinity, Water Temperature-non-specific, ...5.0207

INVENTORY OF LARVAL FISH ...Aquatic Ecology, Brackish Water, Maturity & Growth Stages, ...5.0071

EVALUATION OF HABITAT ALTERATION, CURRITUCK SOUND ...Habitat Studies, North Carolina, Turbidity & Suspended Matter, Water Salinity, ...5.0914

TRAMMEL NET SAMPLING IN ESTUARINE AREAS ...Competition, Estuaries, Lakes, Nets, Population Dynamics, ...5.0096

A STUDY OF THE SEASONAL ABUNDANCE, DISTRIBUTION AND SPECIES COMPOSITION, WITH DEPTH, OF NEKTON FAUNA, WITH PARTICULAR EMPHASIS ON FISHES ...Life History Studies, Number Or Density, Vertical Distribution, Zooplankton, ...5.0114

EXPANSION OF CURRENT AND DEVELOPMENT OF ADDITIONAL COMMERCIAL FISHERIES CATCH, PRODUCTION AND GEAR STATISTICS ...Alaska, Censusing, Commercial Fishing, Fish -other, Reliability Theory, ...5.0018

KVICHAK RIVER TOTAL SMOLT ...Alaska, Censusing, Migration, Mortality Rates, Nets, Population Dynamics, ...5.0002

PORT SAMPLING - CRESENT CITY, BROOKINGS, PORT ORFORD ...Crabs, Life History Studies, Nets, Shrimps - Common, ...5.0356

SEA SURVEY INVESTIGATIONS ...California Current, Population Dynamics, Survey Studies, Vertical Distribution, ...4.0117

DEVELOPMENT OF UNDER-ICE HORIZONTAL SONAR SCANNING EQUIPMENT AND TECHNIQUES FOR LOCATING FISH SCHOOLS ...Behavioral Ecology, Commercial Fishing, Lakes, Nets, Sonar, ...8.0138

STREAM IMPROVEMENT PLANNING ...Benefit-cost Analysis, Engineering Structures-general, Management -other, Planning, Streams, ...5.0220

FISH POPULATION OFF THE ISLAND OF TUTUILA, AMERICAN SAMOA ...American Samoa, Animal Taxonomy, Commercial Fishing, Fishing Gear, Number Or Density, ...5.0032

FISH POPULATIONS OF AMERICAN SAMOA ...American Samoa, Crustacea -non-specific, Fishing Gear, Number Or Density, ...5.0033

GEAR EVALUATION ...American Samoa, Fishing Gear, Nets, ...8.0114

KVICHAK RIVER SMOLT STUDY LITERATURE SURVEY ...Alaska, Censusing, Migration, Number Or Density, Survey Studies, ...5.0003

INTERVIEW AND OBSERVATION ...Censusing, Commercial Fishing, Continental Shelf, Range Or Territorial Distr. , ...5.0156

DESIGN OF SAMPLING PLAN AND PROCUREMENT OF CHARTER VESSEL ...Commercial Fishing, Continental Shelf, Nets, Number Or Density, Vertical Distribution, ...4.0014

WINTER DISTRIBUTION OF FISHES ...Continental Shelf, Environmental Ecology, Salinity, Temperature, Temporal Distribution, Winter, ...5.0153

SPRING DISTRIBUTION OF FISHES ...Commercial Fishing, Continental Shelf, Data Acquisition, Environmental Ecology, Spring, Temporal Distribution, ...5.0154

FISH COLLECTION OF NORTH CAROLINA AND WESTERN ATLANTIC FISHES ...Atlantic Ocean-north, Collections, Fresh Water, North Carolina, ...5.0133

ECOLOGY OF COMMERCIAL FISH SPECIES IN NORTHERN LAKE MICHIGAN ...Commercial Fishing, Lake Michigan, Number Or Density, Population Dynamics, Vertical Distribution, ...5.0112

APPLICATION OF BIOTELEMETRY TO THE STUDY OF MARINE VERTEBRATES ...Biological Sciences, Central Nervous System, Locomotion -animal, Telemeters, Telemetry, ...5.0637

BIOCHEMISTRY AND PHYSIOLOGICAL ECOLOGY OF POISONED FISH ...Enzymes -non-specific, Metabolism, Muscle, Pathology, Toxins -non-specific, ...5.0305

OREGON FISHES - THEIR CLASSIFICATION, DISTRIBUTION AND BIOLOGY ...Animal Taxonomy, Fresh Water, Oregon, Vertical Distribution, ...5.0138

CRYOGENIC PRESERVATION OF VIABLE FISH SPERM ...Fertility, Freezing Techniques, Male Gametes, Rapid Freeze, ...5.0310

EARLY LIFE OF BOREAL FOOD FISH AND SHELLFISH ...Animal Taxonomy, Life History Studies, Mollusks -non-specific & Other, Mortality Rates, ...5.0139

FISH GENETICS AND ECOLOGY ...DNA Other, Estuaries, Life History Studies, ...5.0309

REPRODUCTIVE ISOLATING MECHANISMS IN PANAMANIAN INSHORE MARINE FISHES ...Behavioral Ecology, Comparative Physiology, Panama, Reproduction Studies (general), ...5.0244

STUDY OF FISH MUCUS BIOCHEMISTRY ...Locomotion -animal, Mucus, ...8.0172

BIOLOGICAL FALSE TARGETS AND RELATED ACOUSTIC CHARACTERISTICS ...Animal Taxonomy, Behavioral Ecology, Sound Production, ...1.0041

WATER QUALITY AND NUTRIENTS, SACRAMENTO-SAN JOAQUIN RIVER SYSTEM ...Environmental Ecology, Eutrophication, Nutrients, Plankton (non-specific), Water Quality-general, ...6.0139

DISTRIBUTION OF YOUNG STAGES OF COASTAL FISHES ...Continental Shelf, Estuaries, Maturity & Growth Stages, Number Or Density, Ships and Cruises, ...5.0119

INFLUENCE OF THE PHYSICAL ENVIRONMENT ON DISTRIBUTION OF YOUNG STAGES OF COASTAL GAME FISH ...Continental Shelf, Environmental Ecology, Maturity & Growth Stages, Physical-general, Range Or Territorial Distr. , ...5.0211

EXPLORATORY COLLECTION AND CARE OF FISH FOR TESTING AT TIBURON ...Bioassay, California, Laboratory Animals, San Francisco Bay, ...5.0116

THERMAL PREFERENCES OF MARINE FISHES AND INVERTEBRATES ...Behavior, Invertebrates -non-specific, Thermal, Water Temperature-non-specific, ...5.0209

EFFECTS OF HOT WATER MASSES ON MARINE FISHES ...Atlantic Ocean-north, Behavior, High Temp. -85f Or Above, Oceanic Fronts, Thermal, ...5.0210

TOXICANT TOLERANCE STUDIES-SCREENING OF PESTICIDES AND FISH AT TIBURON ...California, Laboratory Animals, Pesticides -non-specific, Screening Potential Pesticides, ...5.0278

LIFE HISTORY AND BEHAVIOR OF FISHES ON ARTIFICAL REEFS ...Behavioral Ecology, Habitat Studies, Life History Studies, Population Dynamics, ...5.0121

HYDROGRAPHY, SEDIMENTATION AND CHEMICAL ASPECTS OF THE REEF ENVIRONMENT ...Aquatic Soils, Currents-ocean, Environmental Ecology, Reefs, ...5.0212

ECOLOGY OF THE KELP FORESTS ...Behavioral Ecology, California, Environmental Ecology, Habitat Studies, Laminariaceae (non-specif.&ot), ...5.0194

1965 SALT-WATER ANGLING SURVEY ...Animal Taxonomy, Censusing, Fishing, ...9.0011

EFFECT OF TEMPERATURES AND CIRCULATION OF CONTINENTAL SHELF WATERS ON THE DISTRIBUTION OF FISHES ...Continental Shelf, Surface Environments, Temperature, Water Movement, Currents,, Water Temperature-non-specific, ...4.0165

METHODS OF REARING EGGS AND LARVAE TO JUVENILE STAGES ...Aquaculture & Fish-farming, Captive Rearing, Environmental Physiology, Maturity & Growth Stages, ...8.0010

ATLAS OF MARINE FAUNA ...Atlantic Ocean-north, Crustacea -non-specific, Handbooks, Mollusks -non-specific & Other, ...5.0101

FISH POPULATION STUDY ...Chemical Measurements -water, Commercial Fishing, Food Supply, Population Dynamics, Water Temperature-non-specific, ...5.0174

MARINE BIOLOGICAL INVESTIGATIONS - TAXONOMIC COLLECTION OF THE FRESH AND SALTWATER FISHES OF ALASKA ...Alaska, Animal Taxonomy, Collections, Fresh Water, ...5.0008

GULF OF ALASKA DEMERSAL FISH INVESTIGATIONS ...Gulf of Alaska, Population Dynamics, Productivity (agricultural), Vertical Distribution, ...5.0009

COLLECTION OF JUVENILE MIGRANTS FROM RIVERS AND STREAMS ...Electric Power Plants, Engineering Structures-general, Management -other, Migration, Streams, ...5.0513

ROUTINE SAMPLING AT SEVEN INDEX STATIONS ...Bottom Sampling, Data Acquisition, Lake Erie, Plankton Sampling, Sampling, ...5.0214

YOUNG FISHES OF A TIDAL ZONE ...Estuaries, Habitat Studies, Life History Studies, Size, Temporal Distribution, ...5.0073

FISHES TAKEN INCIDENTAL TO SHRIMP TRAWLING ...Atlantic Ocean-south, Nets, Number Or Density, Shrimps - Common, ...5.0072

SYSTEMATIC STUDIES OF FISHES ...Animal Taxonomy, Developmental Physiology, Life History Studies, Vertebrate Anatomy, ...5.0059

IDENTIFICATION AND DESCRIPTION OF FISH LARVAE ...Animal Taxonomy, Atlantic Ocean-north, Life History Studies, Southern, ...5.0074

BEHAVIOR OF LARVAL FISHES ...Behavior, Captive Rearing, Commercial Fishing, Environmental Physiology, Maturity & Growth Stages, ...5.0062

ARTIFICIAL SELECTION - FISH ...Female Gametes, Genetic Resistance, Pesticides -non-specific, Pollution - Effects of , Selection & Breeding, ...5.0256

GREAT LAKES GEAR RESEARCH ...Commercial Fishing, Fishing Gear, Great Lakes-general, Lakes, Population Dynamics, ...8.0136

MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES ...Great Lakes-general, Insecticides -non-specific, Monitoring Systems, Pollutants-general, Sampling, ...6.0120

ESTABLISHMENT AND PERPETUATION OF STOCKS OF EXPERIMENTAL FISH ...Behavior, Environmental Ecology, Environmental Physiology, Great Lakes-general, Life History Studies, ...5.0109

MARINE FISH BEHAVIOR ...Behavioral Ecology, Commercial Fishing, Fishing Gear, ...5.0176

MARINE BIOLOGICAL INVESTIGATIONS STUDIES PROJECT (FISHES) ...Alaska, Aquatic Ecology, Bays, Population Dynamics, ...5.0011

FISH GUIDING ...Animal Distr. (non-specific), Control Systems, Instrumental Services, Management -other, Water Environment -other, ...8.0015

GREAT LAKES EXPLORATIONS ...Commercial Fishing, Fishing Gear, Great Lakes-general, Population Dynamics, ...5.0108

DESCRIPTIVE PHYSICAL OCEANOGRAPHY OF THE EASTERN TROPICAL ATLANTIC ...Atlantic Ocean-general, Environmental Ecology, Productivity - Food Chain, Tropic, ...4.0127

PHYSIOLOGY OF MARINE ORGANISMS ...Energy, Environmental Physiology, Food Supply, ...5.0939

CALIFORNIA CURRENT SURVEYS ...California Current, Environmental Ecology, Pacific Ocean-east, Plankton (non-specific), ...4.0114

SPECIES LIFE HISTORY AND DISTRIBUTION ...California Current, Life History Studies, Maturity & Growth Stages, Number Or Density, Oceanic Fronts, ...5.0037

FISH HOLDING AND LIFE STAGE SENSITIVITY STUDIES ...Contamination - Water, Environment Resistance, Fish, Great Lakes-general, Maturity & Growth Stages, ...5.0276

MARINE BIOLOGICAL ASSESSMENT OF POLLUTIONAL FATE ...Contamination - Water, Crustacea -non-specific, Nets, Pollution - Effects of , ...6.0176

PARASITES OF PHILIPPINE FISHES ...Animal Distr. (non-specific), Aquatic Ecology, Helminths, Philippines, ...5.0251

PHOTOBIOLOGY OF MARINE ANIMALS ...Bioluminescence, Vertebrate Anatomy, Visual, Visual Organs, ...5.0327

ECOLOGY OF CLOSTRIDIUM BOTULINUM TYPE E IN GREEN BAY ...Great Lakes-general, Microbiological, ...5.0850

ANAEROBIC BACTERIA IN THE MARINE ENVIRONMENT ...Food (epidemiology), Isolation From Nat. environ. , Microbiological, ...5.0846

MARINE TOXINS OF THE TROPICAL PACIFIC ...Algal Metab.(non-specific &ot), Pacific Ocean-general, Polynesia, Toxicology, Toxins, ...6.0113

Fish -other

COMPARATIVE STUDY OF NITROGEN SECRETION IN FISHES ...Comparative Physiology, Fish, Metabolism, Nitrogen, Vertebrate Anatomy, ...5.1022

VISUAL CAPACITIES IN TELEOST FISHES ...Behavior, Behavioral Ecology, Vertebrate Anatomy, Vision, Visual Organs, ...5.0290

MORPHOLOGIC REGULATORY MECHANISMS IN TERRESTRIAL AND MARINE ORGANISMS ...Amphibia -non-specific & Other, Collagen, Developmental Physiology, Metabolism, Porifera, ...5.0982

REGULATION OF AMMONIA EXCRETION IN FISH AND AQUATIC AMPHIBIA ...Ammonium, Anura -other, Kidney and Urinary System, Metabolism, Water, ...5.0269

SYSTEMATICS AND DISTRIBUTION OF WORMFISHES (MICRODESMIDAE) ...Animal Taxonomy, Bone, Collections, Vertebrate Anatomy, Vertical Distribution, ...5.0115

MONOGRAPH OF THE FISHES OF THE ORDER PLECTOGNATHI ...Animal Taxonomy, Bone, Comparative Anatomy, Pubilications -other, Vertebrate Anatomy, ...5.0146

ENDOCRINE REGULATED PROCESSES IN TELEOST FISHES ...Comparative Physiology, Environment Resistance, Hypophysectomy, Osmoregulation, Pituitary, ...5.0288

PHYLOGENETIC SIGNIFICANCE OF SOUND-PRODUCING MECHANISMS OF OPHIDIOID AND RELATED FISHES ...Comparative Anatomy, Sound Production, Vertebrate Anatomy, ...5.0268

FAMILIAL RELATIONSHIPS IN TELEOST FISHES ...Animal Taxonomy, Comparative Anatomy, Genetic, Karyotypes, Nomenclature, Classification, ...5.0148

AUDITORY CAPACITIES OF TELEOST FISHES ...Audition, Auditory, Behavior, Vertebrate Anatomy, ...5.0291

THE EVOLUTION AND CAUSATION OF SOCIAL BEHAVIOR IN ANABANTOID FISHES ...Behavior, Ethological, Reproduction Studies (general), Social Behavior, ...5.0300

COMPARATIVE ETHOLOGY OF FISHES OF THE GENUS MACROPODUS ...Aggression, Behavior, Social Behavior, ...5.0266

PHYSIOLOGICAL STUDIES ON FISHES LACKING HEMOGLOBIN ...Adaptation, Cardiovascular System, Fish, Hemoglobin, Metabolism, Polar, ...5.0241

BEHAVIOR AND SONIC ACTIVITY OF FISHES ...Behavioral Ecology, Environmental Physiology, Sonar, Sound Production, ...1.0047

GERMFREE FISH ...Captive Rearing, Germ Free Animal, immunology, Infectious Conditions and Dis, Vertebrate Anatomy, ...5.0236

LIFE HISTORY STUDY OF THE MOI, POLYDACTYLUS SEXFILIS ...Aquatic Ecology, Life History Studies, Management -other, Tags, ...5.0257

THE DETERMINATION OF THE AVAILABILITY OF SEA ROBINS ...Benthic Fauna, Chesapeake Bay, Nets, Vertical Distribution, ...5.0152

SHELLFISH AND BOTTOMFISH DATA ...Commercial Fishing, Crabs, Legislation, Shrimps - Common, ...5.0357

COLLECTION OF MATERIALS AND DATA FOR AGE-GROWTH ANALYSIS ...Age, Commercial Fishing, Growth Rate, ...5.0330

MARINE SPORTS FISHES RESEARCH ...Delaware Bay, Killifishs - Cyprinodon, Population Dynamics, Water Salinity, Water Temperature-non-specific, ...5.0248

SYSTEMATICS AND ZOOGEOGRAPHY OF THE BLENNIOID FISHES ...Animal Taxonomy, Bone, Nomenclature, Classification, World Wide, ...5.0051

COPEPODS PARASITIC ON NEEDLEFISHES ...Aquatic Ecology, Copepods, Ectoparasites, Nomenclature, Classification, Organic Evolution, ...5.0389

SYSTEMATICS AND BIOLOGY OF EPIPELAGIC AND BATHYPELAGIC FISHES ...Animal Taxonomy, Atlantic Ocean-north, Indian Ocean-general, Vertebrate Anatomy, Vertical Distribution, ...5.0049

OSTEOLOGY AND EVOLUTION OF ISOSPONDYLOUS AND OSTARIOPHYSAN FISHES ...Bone, Organic Evolution, Vertebrate Anatomy, ...5.0053

BIOLOGY, MORPHOLOGY, AND EVOLUTION OF THE DISK-FISHES OR SHARKSUCKERS ...Animal Taxonomy, Ethological, Host Specificity, Vertebrate Anatomy, ...5.0250

SYSTEMATIC REVISION PLATYCEPHALIDAE (PISCES) ...Classical, Indian Ocean-general, Museum, Nomenclature, Classification, ...5.0050

STUDIES OF FISH FAMILIES ARIIDAE AND ASPREDINIDAE ...Animal Taxonomy, Interbiotic Relat.(non-specif), Neotropical, Tropic, ...5.0052

TAXONOMIC STUDIES ...Animal Taxonomy, Nomenclature, Classification, Pacific Ocean-east, ...5.0034

DIURNAL-NOCTURNAL ACTIVITY OF THE QUEENFISH, SERIPHUS POLITUS ...Aquatic Ecology, Behavioral Ecology, Biological Rhythms, Drums, Other, Sound Production, ...5.0230

THE ROLE OF THE SENORITA, OXYJULIS CALIFORNICA, AS A CLEANING ORGANISM ...California, Ectoparasites, Fishery Development -other, Interbiotic Relat.(non-specif), ...5.0193

ABUNDANCE AND MIGRATION STUDIES OF THE WHITE SEAPERCH (P. FURCATUS), PILE PERCH (R. VACCA), STRIPED SEAPERCH (E. LATERALIS) AND STARRY FLOU ...Environmental Ecology, Migration, Number Or Density, Oregon, Righteye Flounders, ...5.0934

HYPOTHETICAL DISTRIBUTION OF 14 SPECIES OF ATLANTIC COASTAL GAME FISHES ...Aquatic Ecology, Atlantic Ocean-general, Environmental Ecology, Water Temperature-non-specific, ...5.0123

PELAGIC FISH EXPLORATIONS ...Codfishes, Hake, Commercial Fishing, Nets, Vertical Distribution, ...5.0172

BOTTOMFISH EXPLORATIONS ...Commercial Fishing, Nets, Pacific Ocean-east, Vertical Distribution, ...5.0168

THE EFFECTS OF RADIATION ON THE PHYSIOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Cooperative-studies, Radioactive Fallout, ...5.0294

THE EFFECTS OF RADIATION ON THE MORPHOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Cooperative-studies, Radiation Sensitivity-, Vertebrate Anatomy, Vertebrates Excl. man, ...5.0295

STUDIES ON OPHIDIOID FISHES ...Abyssal, Animal Taxonomy, Benthic Fauna, Vertebrate Anatomy, Vertical Distribution, ...5.0054

STUDIES ON ANACANTHINE FISHES ...Animal Taxonomy, Atlantic Ocean-north, Continental Shelf, Pubilications -other, ...5.0048

BOTTOMFISH EXPLORATIONS ...Bering Sea, Gulf of Alaska, Nets, Vertical Distribution, ...5.0030

FISH POPULATION STUDY ...Analog Computer Applications, Environmental Ecology, Killifishs - Cyprinodon, Population Dynamics, Tilapia, Cichlids, ...5.0175

THE OCEANOGRAPHY OF NEW ENGLAND FISHING BANKS ...Continental Shelf, Number Or Density, Vertical Distribution, Water Environment -other, ...5.0901

IMMUNE MECHANISMS AND RESISTANCE FACTORS IN MARINE FISHES ...Antigen, Histochemical Test, Serology and Immunology, ...5.0255

VISUAL PROJECTION IN SUBMAMMALIAN VERTEBRATES ...Basic Studies, Cranial and Nuclii, Retina, Visual Organs, ...5.0238

Gambusia, Molly

EVOLUTION OF ALL-FEMALE FISHES ...Female, Other, Reproduction Studies (general), ...5.0247

PHYSIOLOGY AND ASSAY OF PROLACTIN IN FISH ...Bioassays, Biochemical, Immunology, Luteotrophic Hormone, Pituitary, ...5.0329

Killifishs - Cyprinodon

STUDIES OF FISH ENDOCRINOLOGY ...Environmental Physiology, Fresh Water, Hormone, Testes, Thyroid, ...5.0246

DEVELOPMENTAL ANALYSIS OF FUNDULUS ...Basic Embryology, Central Nervous System, Fats, Phospholipids, Transplants, ...5.0316

THE INFLUENCE OF ENVIRONMENTAL FACTORS UPON DEVELOPING MERISTIC STRUCTURES IN THE MARINE FISH, FUNDULUS MAJALIS (WALBAUM) ...Basic Embryology, Developmental Physiology, Environmental Physiology, Water Temperature-non-specific, ...5.0298

MARINE SPORTS FISHES RESEARCH ...Delaware Bay, Fish - other, Population Dynamics, Water Salinity, Water Temperature-non-specific, ...5.0248

FISH POPULATION STUDY ...Analog Computer Applications, Environmental Ecology, Fish -other. Population Dynamics, Tilapia, Cichlids, ...5.0175

HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE FISHES ...Contamination - Water, Pathology, Pollution - Effects of , Pollution Effects, ...5.0323

HEMATOLOGICAL CHANGES IN F. HETEROCLITUS UPON EXPOSURE TO TOXIC METALS ...Blood Cells, Blood Plasma and Serum, Cadmium, Lead, Toxins -other, ...5.0325

PHARMACOLOGY OF METAL POISONING IN ESTUARINE FISHES ...Contamination - Water, Estuaries, Metals -non-specific, Stress, ...5.0324

COMPARATIVE TOXICITIES OF METALS TO ESTUARINE FISHES ...Bioassays, Estuaries, Industrial Wastes, Solid Waste, Toxins -other, ...6.0184

Lake Trout, Brook Trout

COMPARATIVE BEHAVIOR OF HATCHERY-REARED AND WILD SALMONIDS ...Atlantic Salmon, Sebago Salmon, Behavior, Captive Rearing, Environmental Physiology, ...5.0264

INVESTIGATION OF ANADROMOUS DOLLY VARDEN POPULATIONS IN HOOD BAY DRAINAGES, SOUTHEASTERN ALASKA ...Alaska, Migration, Population Dynamics, Streams, ...5.0013

ASSESSMENT OF LAKE SUPERIOR LAKE TROUT ...Aquatic Ecology, Commercial Fishing, Lampreys, Life History Studies, ...5.0736

RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...Fish, Insecticides -non-specific, Lake Michigan, Lake Superior, Pollution Effects, Salmon -coho,chinook,sockeye.., ...6.0154

Lampreys

BIOLOGY OF THE LARVAL SEA LAMPREY ...Control of Nuisance Species, Developmental Physiology, Environmental Ecology, Great Lakes-general, Life History Studies, ...5.0633

EFFECTS OF CHEMICALS ON THE PHYSIOLOGY OF SEA LAMPREY AMMOCETES (PETROMYZON MARINUS) ...Contamination - Water, Control of Nuisance Species, Environmental Physiology, Maturity & Growth Stages, ...5.0631

ASSESSMENT OF LAKE SUPERIOR LAKE TROUT ...Aquatic Ecology, Commercial Fishing, Lake Trout, Brook Trout, Life History Studies, ...5.0736

LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...Aquatic Ecology, Control of Nuisance Species, Lake Superior, Larvicides, Streams, ...5.0628

LAKE MICHIGAN CHEMICAL CONTROL OF SEA LAMPREY ...Animal Pollutant Sources, Control of Nuisance Species, Evaluation, Lake Michigan, Larvicides, ...6.0158

SEA LAMPREY AMMOCETE REESTABLISHMENT STUDIES ...Aquatic Ecology, Control of Nuisance Species, Great Lakes-general, Larvicides, Life History Studies, Population Dynamics, ...5.0629

ELECTRIC BARRIER OPERATIONS ...Control of Nuisance Species, Lake Michigan, Lake Superior, Migration, Population Dynamics, ...5.0630

BIOASSAY ...Animal Pollutant Sources, Evaluation, Piscicides - non-specific, Streams, Water Properties-general, ...5.0632

Largemouth Bass

EXPERIMENTAL AND BIOMATHEMATICAL ANALYSIS OF THE PHENOMENON OF ATTACK ...Behavioral Ecology, Bluegills, Bream, Computer Methods -general, Environmental Physiology, Minnows, Predation, ...5.0535

Lefteye Flounders

CREEL CENSUS OF SUMMER FLOUNDER SPORT FISHERY IN GREAT BAY, NEW JERSEY ...Bays, Censusing, Legislation, Life History Studies, New Jersey, ...5.0124

POPULATION DYNAMICS OF NEW ENGLAND GROUNDFISH ...Atlantic Ocean-north, Codfishes, Hake, Population Dynamics, Rockfish, Scoraionfish, ...5.0103

Marlin, Billfishes, Sailfish..

LIFE HISTORY OF BILLFISHES ...California , Censusing, Life History Studies, Mexico, ...5.0195

ENVIRONMENTAL EFFECTS ON ISTIOPHORID FISH DISTRIBUTION ...Environmental Ecology, Gulf of Mexico, Ships and Cruises, Temporal Distribution, ...5.0070

BLOOD TYPES AS INDICATORS OF WHITE MARLIN RACES ...Blood Plasma and Serum, Blood Typing Studies, Polymorphism, Statistics-general, ...5.0321

HEMOGLOBIN VARIATIONS AS INDICATORS OF WHITE MARLIN RACES ...Hemoglobin, Morphological Action, ...5.0322

TAGGING PROGRAM WITH WOODS HOLE AND INTERNATIONAL GAME FISH ASSOCIATION FOR MARLIN, SAILFISH AND OTHER GAME SPECIES MIGRATION STUDIES ...Migration, Pacific Ocean-general, Population Dynamics, Tags, ...5.0036

Minnows

CYTOTAXONOMIC STUDIES OF TELEOST FISHES ...Abyssal, Animal Taxonomy, Blood Cells, Sets of Chromosomes, ...5.0242

EXPERIMENTAL AND BIOMATHEMATICAL ANALYSIS OF THE PHENOMENON OF ATTACK ...Behavioral Ecology, Bluegills, Bream, Computer Methods -general, Environmental Physiology, Largemouth Bass, Predation, ...5.0535

Pikes, Pickeral, Muskellunge

FISH POPULATIONS IN THE CHENA RIVER ...Alaska, Population Dynamics, Salmon & Trout - Non-specific, Streams, ...5.0029

Pompanos, Scads, Jacks

CULTURE OF POMPANO IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Brackish Water, Food Supply, Louisiana, Stocking of Fish & Shellfish, ...8.0004

SYSTEMATICS OF CARANGID FISHES ...Animal Taxonomy, Collections, Handbooks, Maturity & Growth Stages, Species, Comparison of , ...5.0061

Porgies

SPORT FISH BEHAVIORAL STUDIES ...Basses -sea,white, White Perch, Behavioral Ecology, Habitat Studies, Rockfish, Scoraionfish, ...5.0045

Rainbow Trout, Steelhead Trout

EVALUATION, COORDINATION, AND PLANNING OF PACIFIC SALMON AND STEELHEAD RESEARCH AND MANAGEMENT ACTIVITIES ...Commercial Fishing, Fishery

Development -other, Management -other, Meetings, Salmon - coho,chinook,sockeye.., ...5.0140

OCCURRENCE OF THE PROTOZOAN PARASITE CERATOMYXA IN ADULT PACIFIC SAIMON AND STEELHEAD TROUT ...Infectious Conditions and Dis, Pathology, Protozoa, Protozoa -other, Vertebrate Pathology, ...5.0308

INVENTORY SURVEYS OF OREGON COASTAL STREAMS ...Management -other, Oregon, Salmon & Trout - Non-specific, Spawning & Nesting Sites, Streams, ...5.0217

ANALYSIS OF SALMONID SCALES ...Age, Animal Taxonomy, Columbia River, Growth Rate, Salmon -coho,chinook,sockeye.., Scales, ...5.0315

Rays, Skates, Mantas, Sawfish

DISTRIBUTION AND MIGRATION OF CENTRAL AMERICAN FRESHWATER ELASMOBRANCHS ...Caribbean Sea, Migration, Nicaragua, Osmoregulation, Sharks, ...5.0117

OSMOREGULATION ...Aquatic Ecology, Osmoregulation, Sharks, Streams, ...5.0280

Righteye Flounders

PRELIMINARY STUDY TO DETERMINE ABUNDANCE AND RECRUITMENT OF BOTTOMFISH OFF OREGON ...Nets, Number Or Density, Oregon, Pacific Ocean-general, ...5.0136

TAGGING ENGLISH SOLE, PETRALE SOLE, AND PACIFIC COD ...Codfishes, Hake, Commercial Fishing, Migration, Size, Tags, Washington, ...5.0158

IDENTIFICATION OF WINTER FLOUNDER SUBPOPULATIONS ...Commercial Fishing, Legislation, Nets, Population Dynamics, Tags, ...5.0100

TAG RECOVERY, ENGLISH SOLE, PETRALE SOLE, AND PACIFIC COD ...Codfishes, Hake, Migration, Population Dynamics, Tags, Washington, ...5.0159

SAMPLING OF GROUNDFISH STOCKS ...Age, Bone, Codfishes, Hake, Proprioceptors, Size, ...5.0160

ABUNDANCE AND MIGRATION STUDIES OF THE WHITE SEAPERCH (P. FURCATUS), PILE PERCH (R. VACCA), STRIPED SEAPERCH (E. LATERALIS) AND STARRY FLOU ...Environmental Ecology, Fish -other, Migration, Number Or Density, Oregon, ...5.0934

BIOLOGICAL STUDIES OF NORTHWEST ATLANTIC GROUNDFISH ...Atlantic Ocean-north, Codfishes, Hake, Freshwater Mussels, Scallops, Rockfish, Scoraionfish, ...5.0104

MARINE BIOLOGICAL INVESTIGATIONS - JAPANESE FISHERY OBSERVERS PROJECT ...Commercial Fishing, Gulf of Alaska, Japan, Nets, ...5.0012

EPIDERMAL PAPILLOMAS IN PLEURONECTID FISHES ...Cancer, Papillomas of Animals, Pathology, Puget Sound, ...5.0314

Rockfish, Scoraionfish

SPORT FISH BEHAVIORAL STUDIES ...Basses -sea,white, White Perch, Behavioral Ecology, Habitat Studies, Porgies, ...5.0045

MANAGEMENT OF THE OREGON TRAWL FISHERY ...Censusing, Commercial Fishing, Legislation, Nets, Oregon, ...5.0145

POPULATION DYNAMICS OF NEW ENGLAND GROUNDFISH ...Atlantic Ocean-north, Codfishes, Hake, Lefteye Flounders, Population Dynamics, ...5.0103

BIOLOGICAL STUDIES OF NORTHWEST ATLANTIC GROUNDFISH ...Atlantic Ocean-north, Codfishes, Hake, Freshwater Mussels, Scallops, Righteye Flounders, ...5.0104

GROUNDFISH INVESTIGATIONS (POTENTIAL YIELD OF UNDERUTILIZED GROUNDFISH STOCKS) ...Codfishes, Hake, Commercial Fishing, Legislation, Number Or Density, ...5.0171

Salmon & Trout - Non-specific

EFFECTS OF IRRADIATION, TEMPERATURE AND OTHER ENVIRONMENTAL FACTORS ON SALMONID EMBRYOS ...Basic Embryology, Radiation Effects-non-specific, Water Light Quality & Quantity, Water Temperature-non-specific, X and Gamma Rays, ...5.0336

SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES ...Behavior, Migration, Olfactory, Visual Organs, ...5.0339

FISH POPULATIONS IN THE CHENA RIVER ...Alaska, Pikes, Pickeral, Muskellunge, Population Dynamics, Streams, ...5.0029

MONITORING THE EFFECTS OF LAND USE ON SALMON PRODUCTION ...Alaska, Environmental Ecology, Land Use, Pulp, Paper , and Logging, Streams, ...5.0192

ARCTIC-YUKON-KUSKOKWIM AREA ANADROMOUS FISH INVESTIGATIONS ...Alaska, Commercial Fishing, Life History Studies, Population Dynamics, Salmon -coho,chinook,sockeye.., ...5.0024

WATER QUALITY AS RELATED TO SURVIVAL OF SALMON EGGS AND LARVAE ...Environmental Ecology, Mortality Rates, Reproduction Studies (general), Spawning & Nesting Sites, Water Quality-general, ...5.0227

ESTUARINE WATER QUALITY AND FISH DISTRIBUTION ...Contamination - Water, Environmental Physiology, Estuaries, Pollution Effects, Pulp, Paper , and Logging, ...5.0178

TAGGING SALMON IN THE OFFSHORE WATERS OF THE NORTH PACIFIC ...Bering Sea, Gulf of Alaska, Migration, Number Or Density, Range Or Territorial Distr. , Tags, ...5.0180

EPIDEMIOLOGY OF SALMON POISONING DISEASE ...Epizootic, Helminths, Infectious Conditions and Dis, Pathology, Water Salinity, ...5.0306

INFECTIOUS DISEASES OF SALMONID FISHES ...Bacteria (non-specific), Infectious Conditions and Dis, Mode of Transmission, Pathology, Protozoa -other, ...5.0302

EFFECTS OF KRAFT PULP MILL EFFLUENTS ON THE GROWTH AND PRODUCTION OF FISH ...Contamination - Water, Industrial Wastes, Pollution - Effects of , Pollution Effects, Population Dynamics, Pulp, Paper , and Logging, ...5.0311

NUTRITION OF SALMONID FISHES ...Captive Rearing, Diet Or Ration -other, in Vivo--see Also Feed Rations, Purified Diets, ...5.0304

UTILIZATION OF LATENT MARINE RESOURCES AND WASTE PRODUCTS ...Fish -other, Fish Meals, Fish Protein Concentrate, Proteins, Proteins and Amino Acids, ...6.0068

SURVEYS OF SPAWNING SALMON ...Biological Rhythms, Censusing, Number Or Density, Oregon, Streams, ...5.0142

INVENTORY SURVEYS OF OREGON COASTAL STREAMS ...Management -other, Oregon, Rainbow Trout, Steelhead Trout, Spawning & Nesting Sites, Streams, ...5.0217

ADULT SALMON BEHAVIOR STUDIES IN RIVERS AND AT DAMS (SONIC TRACKING) ...Behavioral Ecology, Engineering Structures-general, Streams, Tags, Telemetry, ...8.0111

JUVENILE MIGRATION RATES ...Columbia River, Mark, Tag Or Capture -other, Migration, Snake River, Water Environment -other, ...5.0223

CHARACTERISTICS OF LAKE SUPERIOR WHITEFISH ...Commercial Fishing, Interbiotic Relat.(non-specif), Lake Superior, Life History Studies, Tags, ...5.0183

RELATION OF RIVER-RUN IMPOUNDMENTS TO SALMON PRODUCTION ...Aquatic Ecology, Engineering Structures-general, Environmental Changes, Environmental Ecology, Mans Activities, Pollution - Effects of , ...5.0222

SALMON PRODUCTION IN AREAS MADE INACCESSIBLE BY DAMS ...Aquatic Ecology, Columbia River, Engineering Structures-general, Environmental Ecology, Spawning & Nesting Sites, ...5.0224

ADULT SALMON BEHAVIOR STUDIES IN RIVERS AND AT DAMS %SONIC TRACKING40 ...Columbia River, Construction Land Use Effects, Migration, Pre-impoundment Sites, Telemetry, ...5.0169

DROPOUT OF SALMON FROM GILL NETS ...Commercial Fishing, Management -other, Mortality Rates, Nets, Water Salinity, ...5.0177

PREDICTION OF ENVIRONMENT ...Biological-general, Columbia River, Environmental Ecology, Low Temp. -but Above 32f, Physical-general, Reservoirs and Impoundments, Snake River, Temperature, Thermal Pollution, ...5.0225

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DEVELOPMENT OF FISHNET BATHYKMORGRAPH ...Fishing Gear, Instrumental Services, Nets, Readout Systems, ...8.0102

CTFM SONAR ...Behavioral Ecology, Locomotion -animal, Sonar and Echo Sounding, Telemetry, Tuna, Mackerel, Albacore... , ...8.0058

MULTISPECIES FISHERIES MODELS ...California, Economics, Model Studies, Oceanic - Pelagic, Pacific Ocean-east, Production & Processing, ...4.0065

OCEANOGRAPHIC STUDY OF NORTHEASTERN U. S. COASTAL WATERS FOR INTERNATIONAL COMMISSION FOR NORTHWEST ATLANTIC FISHERIES ...Gases, Salinity, Ships and Cruises, Temperature, ...4.0123

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SHARK RESEARCH ...Fish Repellents, Sharks, Tags, Temporal Distribution, ...5.0047

BIOLOGY OF THE LARVAL SEA LAMPREY ...Developmental Physiology, Environmental Ecology, Great Lakes-general, Lampreys, Life History Studies, ...5.0633

NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...Behavioral Ecology, Competition, Environmental Ecology, Oysters, Predation, ...5.0377

METHODS OF CONTROL OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...Competition, Gastropods -slugs,conch,snails, Oysters, Predation, ...5.0378

EFFECTS OF CHEMICALS ON THE PHYSIOLOGY OF SEA LAMPREY AMMOCETES (PETROMYZON MARINUS) ...Contamination - Water, Environmental Physiology, Lampreys, Maturity & Growth Stages, ...5.0631

LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...Aquatic Ecology, Lake Superior, Lampreys, Larvicides, Streams, ...5.0628

LAKE MICHIGAN CHEMICAL CONTROL OF SEA LAMPREY ...Animal Pollutant Sources, Evaluation, Lake Michigan, Lampreys, Larvicides, ...6.0158

SEA LAMPREY AMMOCETE REESTABLISHMENT STUDIES ...Aquatic Ecology, Great Lakes-general, Lampreys, Larvicides, Life History Studies, Population Dynamics, ...5.0629

ELECTRIC BARRIER OPERATIONS ...Lake Michigan, Lake Superior, Lampreys, Migration, Population Dynamics, ...5.0630

Fish Studies -other

COLLECTION, COMPILATION, AND ANALYSIS OF GULF CATCH STATISTICS AND LOGBOOK DATA ...Alewife,menhaden,shad,herring, Commercial Fishing, Computer Methods -general, ...5.0126

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SPORTFISH YIELD OF NATURAL REEFS ...Bays, California, Habitat Studies, Population Dynamics, ...5.0199

EVALUATION, COORDINATION, AND PLANNING OF PACIFIC SALMON AND STEELHEAD RESEARCH AND MANAGEMENT ACTIVITIES ...Commercial Fishing, Management -other, Meetings, Rainbow Trout, Steelhead Trout, Salmon -coho,chinook,sockeye.., ...5.0140

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THE ROLE OF THE SENORITA, OXYJULIS CALIFORNICA, AS A CLEANING ORGANISM ...California, Ectoparasites, Fish -other, Interbiotic Relat.(non-specif), ...5.0193

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THE STATUS AND POTENTIAL OF AQUACULTURE ...Algal Culture, Aquaculture & Fish-farming, Fish -non-specific, Survey Studies, ...8.0003
OYSTER FATNESS STUDY ...Aquaculture & Fish-farming, Fats - Lipids & Oils, Growth Rate, Invertebrate Nutrition, Oysters, ...5.0512
DETERMINATION OF THOSE MARINE SPECIES HAVING THE GREATEST KNOWN POTENTIAL FOR THE COMMERCIAL FISHERY ...Ag Uses of Nat. resource-other, Alginate, Commercial Fishing, Fucus, Phaeophyta (non-specific & Ot), ...5.0098
FOOD HABITS STUDY OF ORGANISMS OF THE CALIFORNIA CURRENT SYSTEM ...Behavioral Ecology, California, California Current, Pacific Ocean-general, ...5.0044
CULTURE OF POMPANO IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Brackish Water, Louisiana, Pompanos, Scads, Jacks, Stocking of Fish & Shellfish, ...8.0004
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CULTURE OF POMPANO IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Brackish Water, Food Supply, Louisiana, Pompanos, Scads, Jacks, ...8.0004

CULTURE OF SHELLFISH IN ARTIFICIAL AND NATURAL SALT PONDS ...Captive Rearing, Growth Rate, Oysters, Ponds, Streams, ...5.0444

EXPERIMENTAL SEEDING (SHRIMP AQUACULTURE PROGRAM) ...Captive Rearing, Florida, Population Dynamics, Shrimps - Common, Spawning & Nesting Sites, ...5.0501

Tags

SHARK RESEARCH ...Control of Nuisance Species, Fish Repellents, Sharks, Temporal Distribution, ...5.0047

LIFE HISTORY STUDY OF THE MOI, POLYDACTYLUS SEXFILIS ...Aquatic Ecology, Fish -other, Life History Studies, Management -other, ...5.0257

TAGGING ENGLISH SOLE, PETRALE SOLE, AND PACIFIC COD ...Codfishes, Hake, Commercial Fishing, Migration, Righteye Flounders, Size, Washington, ...5.0158

TAG DETECTION ...Commercial Fishing, Number Or Density, Puget Sound, Salmon -coho,chinook,sockeye.., Streams, ...8.0148

TAG LOSS ...Captive Rearing, Salmon -coho,chinook,sockeye.., Size, Washington, Weight, ...5.0157

IDENTIFICATION OF WINTER FLOUNDER SUBPOPULATIONS ...Commercial Fishing, Legislation, Nets, Population Dynamics, Righteye Flounders, ...5.0100

MANAGEMENT INVESTIGATIONS OF TWO SPECIES OF SPINY LOBSTERS PANULIRUS JAPONICUS AND P. PENICILLATUS ...Captive Rearing, Commercial Fishing, Lobsters, Management -other, ...5.0422

DUNGENESS CRAB POPULATION DYNAMICS STUDY ...Alaska, Crabs, Life History Studies, Population Dynamics, ...5.0346

INVESTIGATION OF SPAWNING GROUND POTENTIALS AND GROWTH AND SURVIVAL OF JUVENILE SOCKEYE SALMON IN FRAZER LAKE SYSTEM ...Alaska, Censusing, Lakes, Nets, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, ...5.0190

A STUDY OF THE RATE AND PATTERN OF SHAD MIGRATION IN THE CONNECTICUT RIVER UTILIZING SONIC TRACKING APPARATUS ...Alewife,menhaden,shad,herring, Connecticut River, Migration, Spawning & Nesting Sites, Telemetry, ...5.0046

IDENTIFICATION OF RED SALMON STOCKS TAKEN IN THE CAPE KUMLIK-ANIAKCHAK BAY FISHERY (CHIGNIK AREA) ...Alaska, Commercial Fishing, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, Streams, ...5.0021

TAG RECOVERY, ENGLISH SOLE, PETRALE SOLE, AND PACIFIC COD ...Codfishes, Hake, Migration, Population Dynamics, Righteye Flounders, Washington, ...5.0159

TAGGING PROGRAM ...Lobsters, Long Island Sound, Number Or Density, Population Dynamics, Temporal Distribution, ...5.0372

TAG EXTRACTION ...Salmon -coho,chinook,sockeye.., ...8.0149

RECOVERY OF MARKED COHO ...Captive Rearing, Data Acquisition, Salmon -coho,chinook,sockeye.., ...5.0163

TAGGING SALMON IN THE OFFSHORE WATERS OF THE NORTH PACIFIC ...Bering Sea, Gulf of Alaska, Migration, Number Or Density, Range Or Territorial Distr. , Salmon & Trout - Non-specific, ...5.0180

ALBACORE TUNA ...Behavioral Ecology, Environmental Ecology, Life History Studies, Tuna, Mackerel, Albacore... , ...5.0143

MANAGEMENT OF OREGON DUNGENESS CRAB RESOURCE ...Commercial Fishing, Crabs, Legislation, Life History Studies, Oregon, ...5.0489

MIGRATORY HABITS OF LARGE SHARKS ...Atlantic Ocean-north, Fishing, Migration, Sharks, ...5.0147

TRACKING MIGRATIONS OF BLUEFISH POPULATIONS ALONG ATLANTIC COAST TO LEARN BIOLOGY OF THE SPECIES (MIGRATORY HABITS OF BLUEFISH) ...Atlantic Ocean-north, Bluefish, Migration, Population Dynamics, ...5.0120

TAGGING PROGRAM WITH WOODS HOLE AND INTERNATIONAL GAME FISH ASSOCIATION FOR MARLIN, SAILFISH AND OTHER GAME SPECIES MIGRATION STUDIES ...Marlin, Billfishes, Sailfish.., Migration, Pacific Ocean-general, Population Dynamics, ...5.0036

TAGGING ...Alewife,menhaden,shad,herring, Migration, Population Dynamics, Telemetry, Vertebrate Anatomy, ...5.0127

ADULT SALMON BEHAVIOR STUDIES IN RIVERS AND AT DAMS (SONIC TRACKING) ...Behavioral Ecology, Engineering Structures-general, Salmon & Trout - Non-specific, Streams, Telemetry, ...8.0111

CHARACTERISTICS OF LAKE SUPERIOR WHITEFISH ...Commercial Fishing, Interbiotic Relat.(non-specif), Lake Superior, Life History Studies, Salmon & Trout - Non-specific, ...5.0183

MIGRATION OF ATLANTIC TUNAS ...Africa, Atlantic Ocean-general, Migration, Tuna, Mackerel, Albacore... , ...5.0064

OCEAN GROWTH AND MORTALITY OF SALMON ...Growth Rate, Mortality Rates, Salmon -coho,chinook,sockeye.., Scales, ...5.0170

FISH TRANSPORTATION ...Aquatic Ecology, Management -other, Migration, Salmon & Trout - Non-specific, Streams, ...8.0013

SURF CLAM BIOLOGY ...Age, Clams, Growth Rate, Life History Studies, Reproductive System, ...5.0449

Telemetry

A STUDY OF THE RATE AND PATTERN OF SHAD MIGRATION IN THE CONNECTICUT RIVER UTILIZING SONIC TRACKING APPARATUS ...Alewife,menhaden,shad,herring, Connecticut River, Migration, Spawning & Nesting Sites, Tags, ...5.0046

UPGRADING CONVENTIONAL FISHING TECHNIQUES ...Commercial Fishing, Fishing Gear, Nets, Pacific Ocean-north, Sonar, ...8.0150

DEVELOPMENT OF NEW FISHING TECHNIQUES ...Commercial Fishing, Diving and Scuba, Fishing Gear, Geomorphology-topography, Mark, Tag Or Capture -other, Photography, ...8.0151

TAGGING ...Alewife,menhaden,shad,herring, Migration, Population Dynamics, Tags, Vertebrate Anatomy, ...5.0127

ADULT SALMON BEHAVIOR STUDIES IN RIVERS AND AT DAMS (SONIC TRACKING) ...Behavioral Ecology, Engineering Structures-general, Salmon & Trout - Non-specific, Streams, Tags, ...8.0111

ADULT SALMON BEHAVIOR STUDIES IN RIVERS AND AT DAMS %SONIC TRACKING40 ...Columbia River, Construction Land Use Effects, Migration, Pre-impoundment Sites, Salmon & Trout - Non-specific, ...5.0169

CTFM SONAR ...Behavioral Ecology, Commercial Fishing, Locomotion -animal, Sonar and Echo Sounding, Tuna, Mackerel, Albacore... , ...8.0058

Land Use Or Modification

Agricultural Land Use Effects

ECOLOGICAL STUDIES OF ATLANTIC AND GULF COASTAL ESTUARIES OF IMPORTANCE TO WATERFOWL ...Atlantic Ocean-general, Construction Land Use Effects, Estuaries, Gulf of Mexico, Habitat Studies, Waterfowl - non-specific, ...5.0896

Construction Land Use Effects

ECOLOGICAL STUDIES OF ATLANTIC AND GULF COASTAL ESTUARIES OF IMPORTANCE TO WATERFOWL ...Agricultural Land Use Effects, Atlantic Ocean-general, Estuaries, Gulf of Mexico, Habitat Studies, Waterfowl - non-specific, ...5.0896

PRE-CONSTRUCTION ENVIRONMENTAL SURVEY ...Construction Sites, Continental Shelf, Environmental Ecology, Organism Sampling Devices, Reefs, ...5.0907

ADULT SALMON BEHAVIOR STUDIES IN RIVERS AND AT DAMS %SONIC TRACKING40 ...Columbia River, Migration, Pre-impoundment Sites, Salmon & Trout - Non-specific, Telemetry, ...5.0169

PROTECTION OF FINGERLING SALMON IN TURBINES ...Engineering Structures-general, Migration, Mortality Rates, Salmon & Trout - Non-specific, Snake River, ...8.0014

Industry Land Use Effects

OPERATION AND MAINTENANCE OF THE OREGON STATE UNIVERSITY SEAFOODS LABORATORY ...Facilities, Fish & Shellfish, Fish -non-specific, Oregon, ...12.0042

Mammals

Captive Rearing

ECHO RANGING SIGNALS ...Echolocation, Mark, Tag Or Capture -other, Seals, Sonar, Sound Production, ...5.0546

Censusing

WALRUS BIOLOGY AND POPULATION ...Behavioral Ecology, Migration, Population Dynamics, Reproduction Studies (general), Seals, ...5.0523

ADMINISTRATION OF WHALING ACT, PROTECTED AND NON-COMMERCIAL WHALES ...Growth Rate, Mammals, Migration, Reproduction Studies (general), Vertebrate Anatomy, ...5.0669

Food Supply

ADMINISTRATION OF WHALING ACT, COMMERCIALLY UTILIZED WHALES ...Age, Growth Rate, Mammals, Parasitology -other, Reproduction Studies (general), ...5.0668

FUR SEAL RESEARCH, PELAGIC INVESTIGATIONS ...Behavioral Ecology, Seals, Vertical Distribution, ...5.0667

Mammal Studies -other

SEA LIONS ...Mark, Tag Or Capture -other, Maturity & Growth Stages, Metamorphosis, Seals, Spawning & Nesting Sites, ...5.0526

Management -other

ADMINISTRATION OF WHALING ACT - DEVELOPMENT OF RESEARCH TOOLS ...Age, Mark, Tag Or Capture -other, ...5.0670

Mark, Tag Or Capture -other

SEA LIONS ...Mammal Studies -other, Maturity & Growth Stages, Metamorphosis, Seals, Spawning & Nesting Sites, ...5.0526

FUR SEAL RESEARCH, POPULATION DYNAMICS ...Age, Growth Rate, Life History Studies, Population Dynamics, Seals, ...5.0671

ADMINISTRATION OF WHALING ACT - DEVELOPMENT OF RESEARCH TOOLS ...Age, Management -other, ...5.0670

ECHO RANGING SIGNALS ...Captive Rearing, Echolocation, Seals, Sonar, Sound Production, ...5.0546

Stocking of Mammals

SEA OTTER ...Alaska, Metamorphosis, Population Dynamics, Range Or Territorial Distr. , Sea Lions, Fur Seals, ...5.0528

Reptiles

Reptile Studies -other

THE ECOLOGY, MIGRATIONS AND BEHAVIOR OF MARINE TURTLES ...Behavioral Ecology, Migration, Spawning & Nesting Sites, Turtles, Terrapins, Tortoises, ...5.0586

Spawning & Nesting Sites

THE ECOLOGY, MIGRATIONS AND BEHAVIOR OF MARINE TURTLES ...Behavioral Ecology, Migration, Reptile Studies -other, Turtles, Terrapins, Tortoises, ...5.0586

LOCATION OF INSHORE SPAWNING AREAS ...Bluefish, Long Island Sound, Nets, Water Temperature-non-specific, ...5.0201

SEA LIONS ...Mammal Studies -other, Mark, Tag Or Capture - other, Maturity & Growth Stages, Metamorphosis, Seals, ...5.0526

ECOLOGICAL STUDIES OF THE COPPER RIVER DELTA ...Alaska, Censusing, Maps-general, Waterfowl -non-specific, ...5.0855

BREEDING AND MATERNAL BEHAVIOR AMONG THE STELLER SEA LION ...Behavior, Developmental Physiology, Parturition, Seals, ...5.0524

HAIR SEALS ...Age, Dispersion -other, Metamorphosis, Population Dynamics, Seals, ...5.0525

PRE-EMERGENT FRY PINK SALMON FORECAST - SOUTHEASTERN ALASKA ...Alaska, Aquatic Ecology, Censusing, Number Or Density, Salmon -coho,chinook,sockeye.., ...5.0019

KING CRAB SAMPLING GEAR STUDY ...Alaska, Censusing, Crabs, Fishing Gear, Population Dynamics, ...8.0113

INVESTIGATION OF SPAWNING GROUND POTENTIALS AND GROWTH AND SURVIVAL OF JUVENILE SOCKEYE SALMON IN FRAZER LAKE SYSTEM ...Alaska, Censusing, Lakes, Nets, Salmon -coho,chinook,sockeye.., Tags, ...5.0190

LOCATING AND MAPPING THE EXISTING SEED OYSTER BEDS IN DELAWARE BAY ...Aquatic Ecology, Bays, Delaware Bay, Mapping, Oysters, ...5.0381

SURVEY OF A POTENTIAL HARD CLAM FISHERY ...Clams, Commercial Fishing, Coring and Dredging, Estuaries, Georgia, ...5.0420

POTENTIAL FISHERY FOR RIVER HERRINGS IN CONNECTICUT RIVER ...Alewife,menhaden,shad,herring, Connecticut River, Data Acquisition, Life History Studies, Nets, Survey Studies, ...5.0202

PURCHASE OF MATERIALS FOR & CONSTRUCTION OF, FLOATS, RACKS, BAGS, AND TRAYS FOR THE SUSPENSION OF VARIOUS TYPES OF CULTCH ...Biological Rhythms, Derivatives, Equipment Purchase Operation, Oysters, Stocking of Fish & Shellfish, ...8.0008

BIOLOGY OF ANADROMOUS ALOSIDS ...Alewife,menhaden,shad,herring, Mortality Rates, Streams, Tidal Streams, Virginia, ...5.0150

A STUDY OF THE RATE AND PATTERN OF SHAD MIGRATION IN THE CONNECTICUT RIVER UTILIZING SONIC TRACKING APPARATUS ...Alewife,menhaden,shad,herring, Connecticut River, Migration, Tags, Telemetry, ...5.0046

IDENTIFICATION OF RED SALMON STOCKS TAKEN IN THE CAPE KUMLIK-ANIAKCHAK BAY FISHERY (CHIGNIK AREA) ...Alaska, Commercial Fishing, Salmon -coho,chinook,sockeye.., Streams, Tags, ...5.0021

RESTORATION AND REHABILITATION OF EARTHQUAKE DAMAGED PINK AND CHUM SALMON STUDIES IN PRINCE WILLIAM SOUND ...Alaska, Earthquakes, Flow Characteristics -water, Salmon -coho,chinook,sockeye.., Stream Rehabilitation, Tectonics-general, ...5.0191

MEASUREMENT OF SPAWNING SUCCESS AND FRY QUALITY OF CHUM SALMON UTILIZING A SPAWNING CHANNEL AT BIG BEEF CREEK, WASHINGTON ...Management -other, Number Or Density, Quality -non-specific, Salmon -coho,chinook,sockeye.., Washington, ...5.0229

BIOLOGICAL EVALUATION OF EACH EXISTING SEED OYSTER BED IN DELAWARE BAY ...Delaware Bay, Fouling, Number Or Density, Oysters, ...5.0382

LOCATING AND MAPPING HARD BOTTOM AREAS NEAR EXISTING NATURAL SEED OYSTER BEDS ...Bottom Sampling Device, Oysters, ...4.0052

EVALUATION AND STATISTICAL ANALYSIS OF ALL DATA ...Data Analysis - General, Geomorphology-topography, Mapping, Statistics-general, ...4.0018

THE PURCHASE AND INTRODUCTION OF BROOD STOCK ...Low Temp. -but Above 32f, Oysters, Ponds, Stocking of Fish & Shellfish, Warm Water, ...8.0026

THE PURCHASE AND INTRODUCTION OF CULTCH MATERIALS ...Developmental Physiology, Oysters, Ponds, Stocking of Fish & Shellfish, ...8.0009

CONTINUAL MONITORING OF AREA THROUGHOUT SPAWNING, SETTING, AND GROWING PERIOD ...Monitoring (long Term Studies), Oysters, Ponds, ...5.0910

PRE-EMERGENT FRY PINK SALMON FORECAST (KODIAK, ALASKA) ...Alaska, Maturity & Growth Stages, Number Or Density, Salmon -coho,chinook,sockeye.., Streams, ...5.0017

STUDY OF THE RIVER PHASE OF THE LIFE HISTORIES OF ALOSA PSEUDOHARENGUS AND AESTIVALIS ...Alewife,menhaden,shad,herring, Aquatic Ecology, Connecticut River, Life History Studies, ...5.0245

COOK INLET CATCH AND ESCAPEMENT AGE AND SEX COMPOSITION STUDIES ...Age, Alaska, Migration, Nets, Salmon -coho,chinook,sockeye.., Sex -non-specific, ...5.0014

COOK INLET SMOLT ENUMERATION STUDY ...Alaska, Censusing, Productivity (agricultural), Salmon -coho,chinook,sockeye.., ...5.0015

OYSTER SEED PROPAGATION STUDY ...Aquatic Ecology, Bays, Commercial Fishing, Oysters, Pacific Ocean-east, ...8.0012

REPORT DISTRIBUTION ...Commercial Fishing, Fats - Lipids & Oils, Oysters, Periodicals, ...11.0041

WATER QUALITY AS RELATED TO SURVIVAL OF SALMON EGGS AND LARVAE ...Environmental Ecology, Mortality Rates, Reproduction Studies (general), Salmon & Trout - Non-specific, Water Quality-general, ...5.0227

A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY ...Commercial Fishing, Estuaries, Mans Activities, Pollution - Effects of , Texas, ...5.0926

STUDIES OF SOCKEYE SALMON, ONCORHYNCHUS NERKA, IN THE NUSHAGAK DISTRICT, ALASKA ...Alaska, Commercial Fishing, Interbiotic Relat.(non-specif), Lakes, Population Dynamics, Salmon -coho,chinook,sockeye.., ...5.0228

ECOLOGY OF STORM PETRELS ...Albatrosses, Shearwaters... , California, Islands, Mark, Tag Or Capture -other, Terrestrial Ecology, ...5.0532

EFFECTS OF MARSH MANAGEMENT STRUCTURES UPON FISHES ...Alewife,menhaden,shad,herring, Crabs, Engineering Structures-general, Land Use, Shrimps - Common, Swamps-marshes, ...5.0206

EVALUATION OF ESCAPEMENT OF ADULT SALMON TO OREGON COASTAL STREAMS ...Environmental Ecology, Number Or Density, Oregon, Salmon -coho,chinook,sockeye.., Streams, ...5.0215

THE DEVELOPMENT OF HATCHERY TECHNIQUES TO AID IN THE PRODUCTION OF ECONOMIC MOLLUSKS ...Aquaculture & Fish-farming, Captive Rearing, Clams, Food Supply, Oysters, ...5.0483

INVENTORY SURVEYS OF OREGON COASTAL STREAMS ...Management -other, Oregon, Rainbow Trout, Steelhead Trout, Salmon & Trout - Non-specific, Streams, ...5.0217

THE BIOLOGY OF THE LAYSAN AND BLACK-FOOTED ALBATROSSES ...Age, Albatrosses, Shearwaters... , Animal Distr. (non-specific), Control of Nuisance Species, Mark, Tag Or Capture -other, ...5.0607

ECOLOGICAL FACTORS AFFECTING REPRODUCTION OF SHELLFISH (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...Animal Distr. (non-specific), Maturity & Growth Stages, New York, Oysters, Reproductive System, ...5.0374

POTENTIAL OYSTER SETTING CAPACITY - LOCAL AREAS ...Chesapeake Bay, Commercial Fishing, Mark, Tag Or Capture -other, Oysters, Streams, ...5.0445

KARLUK LAKE RESEARCH STATION ...Life History Studies, Mortality Rates, Population Dynamics, Productivity (agricultural), Salmon -coho,chinook,sockeye.., ...5.0006

PINK SALMON INVESTIGATIONS - FRESHWATER ECOLOGY ...Aquatic Ecology, Environmental Ecology, Maturity & Growth Stages, Mortality Rates, Salmon -coho,chinook,sockeye.., ...5.0188

PINK SALMON INVESTIGATIONS - INTERTIDAL ECOLOGY ...Alaska, Life History Studies, Salmon -coho,chinook,sockeye.., Tidal Streams, Water Salinity, ...5.0186

INVESTIGATE SYSTEMATICS AND ECOLOGY OF TUNA LARVAE AND JUVENILES ...Animal Taxonomy, Artifical Insemination, Maturity & Growth Stages, Tuna, Mackerel, Albacore... , ...5.0079

SALMON PRODUCTION IN AREAS MADE INACCESSIBLE BY DAMS ...Aquatic Ecology, Columbia River, Engineering Structures-general, Environmental Ecology, Salmon & Trout - Non-specific, ...5.0224

PINK SALMON INVESTIGATIONS - FRESHWATER ECOLOGY ...Alaska, Aquatic Ecology, Salmon -coho,chinook,sockeye.., Streams, Water Properties-general, ...5.0185

EXPERIMENTAL SEEDING (SHRIMP AQUACULTURE PROGRAM) ...Captive Rearing, Florida, Population Dynamics, Shrimps - Common, Stocking of Fish & Shellfish, ...5.0501

TELEMETRY STUDIES ON MARINE BIRDS ...Albatrosses, Shearwaters... , Bermuda, Mark, Tag Or Capture -other, Pelicans, Cormorants,darters.., ...5.0531

Fish Repellents

SHARK RESEARCH ...Control of Nuisance Species, Sharks, Tags, Temporal Distribution, ...5.0047

BEHAVIOR AND SENSORY PHYSIOLOGY OF SHARKS ...Auditory, Behavioral Ecology, Sharks, Tape Recording, Audio, Visual Organs, ...5.0253

STUDIES OF SHARK REPELLENTS AND OTHER ANTI-SHARK MEASURES ...Shark Repellents, Sharks, ...6.0132

ELASMOBRANCH PHARMACOLOGY ...Drug Evaluation, Mechanism of Action, Sharks, ...6.0119

MARINE ANIMAL TOXINS ...Mechanism of Action, Sharks, Toxins, ...6.0116

Fishing Gear

DESIGN STUDY - AN OPTIMUM FISHING VESSEL FOR THE GEORGES BANK GROUNDFISH FISHERY ...Atlantic Ocean-north, Commercial Fishing, Computer Applications, Naval Architecture-general, Other-design-and-construction, ...8.0288

ESTIMATION OF PARAMETERS OF STRIPED BASS POPULATION AND DESCRIPTION OF THE FISHERY OF LOWER CHESAPEAKE BAY ...Age, Basses -sea,white, White Perch, Censusing, Chesapeake Bay, Population Dynamics, ...5.0151

STUDY ON THE DISTRIBUTION AND ABUNDANCE OF PINK SHRIMP, PANDALUS JORDANI, IN THE PACIFIC OCEAN OFF OREGON ...Censusing, Life History Studies, Pacific Ocean-general, Population Dynamics, Shrimps - Common, ...5.0487

MARINE LABORATORY ...Laboratory Analysis, Louisiana, Nets, Organism Sampling Devices, Technique Development, ...11.0024

PRELIMINARY TESTING OF PELAGIC TRAWLS ON SMALL DRAGGERS ...Barges-towboats, Nets, Oceanic - Pelagic, ...8.0143

KING CRAB SAMPLING GEAR STUDY ...Alaska, Censusing, Crabs, Population Dynamics, Spawning & Nesting Sites, ...8.0113

MANAGEMENT OF THE OCEAN SALMON FISHERY WITH EMPHASIS ON THE BARBLESS HOOKS AS A MANAGEMENT TOOL ...Commercial Fishing, Salmon -coho,chinook,sockeye.., ...8.0142

OPERATIONAL TESTING OF THE PELAGIC TRAWLS ON SMALL DRAGGERS ...Nets, ...8.0144

FISH POPULATION OFF THE ISLAND OF TUTUILA, AMERICAN SAMOA ...American Samoa, Animal Taxonomy, Commercial Fishing, Fish -non-specific, Number Or Density, ...5.0032

FISH POPULATIONS OF AMERICAN SAMOA ...American Samoa, Crustacea -non-specific, Fish -non-specific, Number Or Density, ...5.0033

GEAR EVALUATION ...American Samoa, Fish -non-specific, Nets, ...8.0114

WEIR, TRAP AND SEINE FISHERY ...Censusing, Commercial Fishing, Massachusetts, Nets, ...4.0010

FORECAST OF KODIAK ISLAND PINK SALMON RUNS FROM ABUNDANCE OF JUVENILES IN ESTUARIES ...Alaska, Estuaries, Maturity & Growth Stages, Migration, Number Or Density, Salmon -coho,chinook,sockeye.., ...5.0179

UPGRADING CONVENTIONAL FISHING TECHNIQUES ...Commercial Fishing, Nets, Pacific Ocean-north, Sonar, Telemetry, ...8.0150

DEVELOPMENT OF NEW FISHING TECHNIQUES ...Commercial Fishing, Diving and Scuba, Geomorphology-topography, Mark, Tag Or Capture -other, Photography, Telemetry, ...8.0151

BRISTOL BAY ESTUARINE ECOLOGY ...Alaska, Estuaries, Life History Studies, Migration, Oceanic Fronts, Salmon -coho,chinook,sockeye.., ...5.0004

GREAT LAKES GEAR RESEARCH ...Commercial Fishing, Fish -non-specific, Great Lakes-general, Lakes, Population Dynamics, ...8.0136

OCEAN ENGINEERING ...Bathymetry, Commercial Fishing, Instrumental Services, Telemetry-other, ...8.0152

FISHING GEAR RESEARCH AND DEVELOPMENT ...Commercial Fishing, Meetings, Nets, ...8.0153

MARINE FISH BEHAVIOR ...Behavioral Ecology, Commercial Fishing, Fish -non-specific, ...5.0176

TECHNICAL ASSISTANCE AND LIAISON WITH FISHING INDUSTRIES ...Commercial Fishing, Management -other, Mark, Tag Or Capture -other, ...11.0026

TRAWL DESIGN, MATERIALS AND METHODS ...Commercial Fishing, Nets, ...8.0133

MECHANIZATION OF TRAWL GEAR ...Commercial Fishing, Safety, ...8.0135

TECHNICAL ASSISTANCE TO INDUSTRY ...Alaska, Commercial Fishing, Diffusion of Information, General Information Services, ...5.0031

OCEAN ENGINEERING ...Alaska, Commercial Fishing, Design, Machinery, Equipment, Shrimp, ...5.0349

GREAT LAKES EXPLORATIONS ...Commercial Fishing, Fish -non-specific, Great Lakes-general, Population Dynamics, ...5.0108

DEVELOP HIGH-SEAS TUNA FISHERY ...Commercial Fishing, Pacific Ocean-general, Tropic, Tuna, Mackerel, Albacore... , ...5.0084

DEVELOP FISHERIES FOR NON-TUNA RESOURCES ...Commercial Fishing, Hawaii, Pacific Ocean-general, Snappers, ...5.0086

INCREASE EFFICIENCY OF HAWAIIAN LONGLINE FISHERY ...Commercial Fishing, Fish & Shellfish, Hawaii, Production & Processing, Technique Development, Technological Development, ...11.0022

NORTHERN SHRIMP EXPLORATIONS ...Atlantic Ocean-north, Censusing, Commercial Fishing, Shrimps - Common, ...5.0457

TUNA PURSE SEINE NET ...Commercial Fishing, Nets, Tuna, Mackerel, Albacore... , ...8.0119

DEVELOPMENT OF FISHNET BATHYKMORGRAPH ...Commercial Fishing, Instrumental Services, Nets, Readout Systems, ...8.0102

Flame Research

Combustion

Combustion Products

COMBUSTION OF RESIDUAL FUEL WITH MASSIVE RECIRCULATION ...Alloys, Atmospheric, Gases, Fuels, ...8.0226

A PILOT PLANT STUDY OF LOW EXCESS AIR COMBUSTION - ITS EFFECT ON FIRESIDE PROBLEMS IN OIL FIRED BOILERS ...Boilers, Combustion-other, Fuels, Maintenance-system, ...8.0168

Combustion-other

A PILOT PLANT STUDY OF LOW EXCESS AIR COMBUSTION - ITS EFFECT ON FIRESIDE PROBLEMS IN OIL FIRED BOILERS ...Boilers, Combustion Products, Fuels, Maintenance-system, ...8.0168

UNDERSEA PROPULSION AND POWER SOURCES ...Batteries, Generators, Marine Propulsion, ...8.0158

Florida

DEVELOPMENT OF TECHNIQUES FOR THE AQUACULTURE OF POMPANO ...Aquaculture & Fish-farming, Environmental Physiology, Maturity & Growth Stages, Pathology, Tuna, Mackerel, Albacore... , ...8.0007

AN ECOLOGICAL STUDY OF SOUTH BISCAYNE BAY IN THE VICINITY OF TURKEY POINT ...Applied Ecology, Balance of Nature, Bays, Electric Power Plants, Environmental Ecology, Phytoplankton, Thermal Pollution, ...5.0877

ICHTHYOFAUNA OF THE FLORIDA CURRENT ...Fish -non-specific, Number Or Density, Temporal Distribution, Vertical Distribution, ...5.0066

ECOLOGICAL STUDIES OF THE SOUTHEASTERN FLORIDA SEA GRASS COMMUNITY - PRIMARY PRODUCTION BY THALASSIA TESTUDINUM KONIG ...Elodea, Waterweed, Thalassia, Primary Productivity, Submerged Plants, Translocation, Tropic, ...5.0695

ECOLOGICAL STUDY OF CHARLOTTE HARBOR ESTUARY AND SHARK PROGRAM OF MOTE MARINE LAB ...Estuaries, Mans Activities, Sharks, ...5.0884

FLORIDA CORAL REEF STUDIES ...Drilling and Coring, Environment, Geologic History-general, Quaternary Period, Reefs, ...7.0162

CURATING OF BLAKE PLATEAU CORES ...Collections, Continental Shelf, Core Analysis, ...12.0025

STUDIES OF THE TRANSPORT OF THE FLORIDA CURRENT ...British West Indies, Gulf Stream, Navigation, Ocean Currents-other, Water Motion Recorders, ...2.0017

MARKET RESEARCH STUDIES ON THE EFFECTS OF THE FLORIDA MARKETING PROGRAM ON THE SALE OF FLORIDA SEAFOODS ...Fish -non-specific, Institutional Management, Marketing, Retail, ...6.0018

DESIGN AND CONSTRUCTION OF BARGE AND CLAM DREDGE FOR SURVEY OF FLORIDA'S COMMERCIAL CLAMS ...Clams, Commercial Fishing, Habitat Studies, Other-design-and-construction, ...8.0284

THE NET EFFECT OF WIND ON RECREATIONAL TIDAL STREAMS IN FLORIDA ...Air-sea Boundary-other, Estuaries, Tides, Water Level Fluctuation, Wind-general, ...2.0082

THE BIOLOGY OF THE INFAUNA OF A TROPICAL SOFT BOTTOM AREA ...Aquatic Ecology, Benthic Fauna, Estuaries, Intertidal Areas, Pollution - Effects of , ...5.0879

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OUTGROWTH OF CLOSTRIDIUM BOTULINUM TYPE E IN NONIRRADIATED AND IRRADIATED FISHERY PRODUCTS ...Clostridium Botulinum, Food (epidemiology), Microbiological, Radiation, Refrigeration, ...6.0081

STABILITY OF FOOD LIPIDS TO IONIZING RADIATION ...Fats, Radiation, ...6.0029

STUDY OF THE BASIC MICROBIOLOGICAL AND BIOCHEMICAL FACTORS IN THE IRRADIATION PRESERVATION OF MARINE PRODUCTS ...Bacteria, Microbiological, Radiation, Refrigeration, Staphylococcus (non-spec.& Ot), ...6.0085

RADIOPASTEURIZATION OF FISHERY PRODUCTS-OPERATION AND DEVELOPMENTAL INVESTIGATIONS ...Chemical Analysis, Microbiological, Organoleptic Studies, Radiation, Shelf Life & Storage, ...6.0033

APPLICATION OF RADIATION PASTEURIZATION PROCESSES TO PACIFIC CRAB AND FLOUNDER ...Clostridium Botulinum, Microbiological, Processing, Radiation, Toxicological and Allergy, ...6.0083

RADIATION PRESERVATION OF FISHERY PRODUCTS ...Commercial Fishing, Fish & Shellfish, Organoleptic Studies, Radiation, Shelf Life & Storage, ...6.0034

PREPARATION OF FISH PROTEIN HYDROLYSATES ...Analysis of Foods, Chemical Analysis, Fish Protein Concentrate, Heat, Protein, ...6.0066

MARKET RESEARCH STUDIES ON THE EFFECTS OF THE FLORIDA MARKETING PROGRAM ON THE SALE OF FLORIDA SEAFOODS ...Florida, Institutional Management, Marketing, Retail, ...6.0018

DETERMINATION OF THE STRUCTURE & ECONOMIC IMPORTANCE OF THE VARIOUS SEGMENTS OF THE SEAFOOD INDUSTRY ...Commercial Fishing, Consumer Pref. & Consumption, Fish & Shellfish, Georgia, Production & Processing, Regional Economic Impact, Shellfish -non-specific, ...4.0180

CONSUMER EDUCATION AND MARKET DEVELOPMENT ...Atlantic Ocean-north, Fish & Shellfish, Northeast, ...6.0032

REGIONAL DEMAND IN THE U.S. AND TRENDS IN THE FISHING AND SEAFOOD PROCESSING INDUSTRIES OF THE CHESAPEAKE BAY AREA ...Chesapeake Bay, Commercial Fishing, Consumer Pref. & Consumption, Consumption, Fish & Shellfish, Market Structure, ...6.0028

ESTIMATING THE VALUE ADDED TO SEAFOOD PRODUCTS LANDED IN GEORGIA AT THE VARIOUS STAGES OF THE MARKETING CHANNEL ...Georgia, Processing, Quality -non-specific, Shellfish -non-specific, ...6.0020

ANALYZING THE FACTORS AFFECTING THE DEMAND FOR SEAFOOD AND TO PROJECT THIS DEMAND TO FUTURE TIME PERIODS ...Consumer Pref. & Consumption, Food Needs and Demand, Trends,projections, ...6.0021

CONSUMER EVALUATION OF FISH PRODUCTS ...Consumer Pref. & Consumption, Fish & Shellfish, Organoleptic Studies, Smoking, ...6.0004

ANALYSIS OF THE DEMAND FOR RED MEAT, POULTRY, EGGS, SEAFOOD, AND MEAT MIXTURES ...Consumer Pref. & Consumption, Eggs, Meat -non-specific, Price & Value, ...6.0019

ANTIOXIDANT AND NUTRITIONAL POTENTIAL OF FERMENTED AND UNFERMENTED SOYBEANS IN COMBINATION WITH FISH ...Fermentation, Malting, Food Spoilage Detection, Proteins, Rancidity, Soybeans, ...6.0023

ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST ...Commercial Fishing, Consumer Pref. & Consumption, Market Structure, Northeast, ...4.0183

BIOCHEMISTRY OF FISH AS RELATED TO HUMAN NUTRITION ...Amino Acids, Hypoxanthine, Northeast, ...6.0053

BOTULINUM FOOD POISONING IN RELATION TO FISHERY PRODUCTS ...Antibiotics, Clostridium Botulinum, Great Lakes-general, Microbiological, Repression, ...6.0087

A PROGRAM FOR THE TRAINING OF STAFF MEMBERS FROM THE SCHOOL OF FISHERIES OF THE CATHOLIC UNIVERSITY OF VALPARAISO CHILE ...Chile, Food Processing Industry, Marine Biology, Teaching and Research, ...5.0181

STUDY OF THIAMINASE IN HAWAII FISH ...Enzymatic, Enzyme Inhibitors, Hawaii, Thiaminase, Toxicological and Allergy, ...5.0260

EFFECT OF STORAGE ON FISH MUSCLE PROTEINS ...Fish & Shellfish, Food Raw Quality, Muscle Proteins, Organoleptic Studies, Protein, ...6.0062

NUTRITIVE VALUE OF FISH AND OTHER MARINE PRODUCTS ...Ascorbic Acid, Nutritive Value, Paper Chromatography, Proteins -non-specific, Thiamine, ...6.0054

LIPID OXIDATION AND ASSOCIATED BIOCHEMICAL CHANGES OCCURRING DURING THE PROCESSING AND STORAGE OF FISHERY PRODUCTS ...Anti-oxidants, Chemical Analysis, Fats, Food Spoilage Detection, Rancidity, ...6.0071

DEVELOPMENT OF RADIATION STERILIZED FISH ITEMS FOR ARMED FORCES FEEDING ...Anti-oxidants, Chemical Analysis, Consumer Pref. & Consumption, Military Rations, Radiation, ...6.0073

THE COMPOSITION, NUTRITIVE VALUE AND QUALITY OF FISHERY PRODUCTS WITH SPECIAL EMPHASIS ON LIPID AND ITS INTERACTION ...Anti-oxidants, Fats, Fats - Lipids, Radiation, Unsaturated Fats, ...6.0076

SURVIVAL MECHANISM OF IRRADIATED BACTERIA IN FOODS ...Achromobacter Sp, Antibiotics, Cell Injury and Autolysis, Mutagens, Radiation, ...6.0069

STORAGE STABILITY STUDIES ON RADIATION STERILIZED FISH ITEMS ...Carbohydrates, Fats, Freezing, Protein, Radiation, ...6.0074

OPERATION AND MAINTENANCE OF THE OREGON STATE UNIVERSITY SEAFOODS LABORATORY ...Facilities, Fish & Shellfish, Industry Land Use Effects, Oregon, ...12.0042

THE STRUCTURE OF DECISION MAKING IN MAJOR MARKETING AGENCIES OF FOOD FISH IN THE N.E. UNITED STATES ...Marketing, Northeast, Price & Value, Production & Processing, Shelf Life & Storage, ...6.0078

MARKETING EFFICIENCY IN A COOPERATIVE FOOD-FISH PROCESSING PLANT, A CASE STUDY ...Design, Machinery, Equipment, Fish & Shellfish, Freezing, Processing, Shelf Life & Storage, ...6.0079

DISTRIBUTION OF C. BOTULINUM IN COMMERCIAL SMOKED FISH ...Bacterial Pollutant Sources, Clostridium Botulinum, Food (epidemiology), Microbiological, Smoking, ...5.0337

CHEMISTRY OF FISH OILS AND THEIR UTILIZATION ...Fats, Fats and Oils -other, Fish & Shellfish, Oilseed Processing Technology, ...6.0082

BIOCHEMISTRY OF FISH MUSCLE AND QUALITY CHANGES ...Enzymatic, Food Raw Quality, Muscle, Organoleptic Studies, ...5.1035

PRESERVATION AND DEVELOPMENT OF FOOD PRODUCTS ...Fish & Shellfish, Food Raw Quality, Food Transport -other, Packaging, Processed Product Quality, ...6.0084

IRRADIATION SERVICES AND STUDIES ...Fish & Shellfish, Instrumental Services, Radiation, ...6.0036

COMMERCIAL BENEFIT STUDIES ...Commercial Fishing, Fish & Shellfish, ...6.0037

SHIPBOARD IRRADIATION STUDIES ...Food Raw Quality, Medical Studies, Microbiological, Radiation, Shelf Life & Storage, ...6.0039

FUNDAMENTAL RADIATION CHEMISTRY RESEARCH ...Antibiotics, Chemical Analysis, Packaging, Radiation, Radiochemical Analysis, ...6.0040

INVESTIGATION OF FEASIBILITY OF STERILIZING FISH BY RADIATION ...Enzymatic, Inactivation, Organoleptic Studies, Radiation, Shelf Life & Storage, ...6.0041

PROCESSING AND PRODUCT DEVELOPMENT OF EDIBLE FISH AND SHELLFISH ...Commercial Fishing, Fish & Shellfish, ...6.0047

PRODUCT/PROCESSING DEVELOPMENT RESEARCH ...Design, Machinery, Equipment, Fish & Shellfish, Freezing, Radiation, Refrigeration, ...5.0988

GROWTH AND TOXICOGENESIS OF C. BOTULINUM IN FISHERY PRODUCTS ...Antimetabolites -non-specific, Bacterial Exotoxins, Clostridium Botulinum, Growth (non-specific & Ot.), Medical Studies, Microbiological, ...6.0043

CONTROL OF OXIDATIVE CHANGES IN FRESHWATER FISH ...Chemical Analysis, Freezing, Fresh Water, Organoleptic Studies, Rancidity, ...6.0045

ELECTROPHORETIC PROFILES FOR THE IDENTIFICATION OF FISH SPECIES ...Disc Electrophoresis, Gel Electrophoresis, Infection, Intoxication & Pois, Legal Standards, ...6.0014

COMPOSITION OF BREADED FISH PRODUCTS ...Food Preparation, Heat, Legal Standards, ...6.0015

FERMENTED PROTEIN-RICH FOODS ...Fermentation, Malting, Fungal Toxins, Milk, Peanuts, Soybeans, ...6.0055

EFFECTS OF IONIZING RADIATION ON FOOD LIPIDS ...Animal Fats -non-specific, Fats, Organoleptic Studies, Radiation, ...6.0030

ECOLOGY OF CLOSTRIDIUM BOTULINUM TYPE E IN GREEN BAY ...Great Lakes-general, Microbiological, ...5.0850

ANAEROBIC BACTERIA IN THE MARINE ENVIRONMENT ...Food (epidemiology), Isolation From Nat. environ. , Microbiological, ...5.0846

LOW TEMPERATURE GROWTH OF BACTERIA ON FOODS ...Cryophilic Bacteria, Growth (non-specific & Ot.), Isoenzymes, Microbiological, Refrigeration, Temperature, ...6.0086

ISOLATION OF ANTI-THIAMINE FACTORS IN HAWAII FISH ...Food Spoilage Detection, Radiation, Thiamine, Thiamine Compounds, Vitamins, ...5.0261

Fish -other

EXPANSION OF CURRENT AND DEVELOPMENT OF ADDITIONAL COMMERCIAL FISHERIES CATCH, PRODUCTION AND GEAR STATISTICS ...Alaska, Censusing, Commercial Fishing, Fish -non-specific, Reliability Theory, ...5.0018

UTILIZATION OF HAKE, DOGFISH, AND BY-PRODUCTS OF THE FILLET INDUSTRY FOR PROTEIN SUPPLEMENTS ...Anti-oxidants, Chemical and Spices, Fish Protein Concentrate, Heat, Nutritive Value, Supplements, ...6.0067

UTILIZATION OF LATENT MARINE RESOURCES AND WASTE PRODUCTS ...Fish Meals, Fish Protein Concentrate, Proteins, Proteins and Amino Acids, Salmon & Trout - Non-specific, ...6.0068

COMPOSITION STUDIES OF FISH AND SHELLFISH AS RELATED TO STORAGE AND PROCESSING PROBLEMS ...Crabs, Freezing, Mackerel, Packaging, Rancidity, ...6.0046

CONTAINERIZATION OF FISHERY PRODUCTS ...Commercial Fishing, Packaging, Processing, Shrimp, ...6.0049

EFFECTS OF HANDLING AND PROCESSING PROCEDURES IN POTENTIAL PATHOGENUS ON FISH ...Clostridium Botulinum, Legal Standards, Microbiological, Smoking, Toxicological and Allergy, ...6.0044

INVESTIGATION OF FOOD PRESERVATION METHODS ...Chemical Analysis, Food Processing -other, Food Spoilage - other, Organoleptic Studies, Physical and Chemical Change, ...6.0016

DIMETHYLNITROSAMINE IN CURED, SMOKED WHITE FISH AND FLOUR BLEACHED WITH OXIDES OF NITROGEN ...Ethylene, Fish Protein Concentrate, Flour, Nitroso Compounds, Nitrous Oxide, ...6.0007

LIPASE RESISTANT GLYCERIDES ...Fats, Fats and Oils -other, Lipids, Unsaturated Fats, ...5.1029

Fish Protein Concentrate

RESEARCH AND GRADUATE TRAINING IN FOOD AND DRUGS FROM THE SEA, AND MARINE POLLUTION ...Antimicrobial, Carcinostatic, Chemistry, Pollution Sources-general, Training Grants, Fellowships, ...6.0060

PREPARATION OF FISH PROTEIN HYDROLYSATES ...Analysis of Foods, Chemical Analysis, Fish -non-specific, Heat, Protein, ...6.0066

UTILIZATION OF HAKE, DOGFISH, AND BY-PRODUCTS OF THE FILLET INDUSTRY FOR PROTEIN SUPPLEMENTS ...Anti-oxidants, Chemical and Spices, Fish -other, Heat, Nutritive Value, Supplements, ...6.0067

UTILIZATION OF LATENT MARINE RESOURCES AND WASTE PRODUCTS ...Fish -other, Fish Meals, Proteins, Proteins and Amino Acids, Salmon & Trout - Non-specific, ...6.0068

UTILIZATION AND PREPARATION OF FISH PROTEIN CONCENTRATE ...Chemical Analysis, Fish & Shellfish, Nutritive Value, Organoleptic Studies, Proteins, ...6.0125

PROCESS ENGINEERING ...Design, Machinery, Equipment, Esters, Extraction, Fats and Oils -other, Industrial Operation, Legal Standards, Natural Occurring, ...6.0080

DEVELOPMENT OF MECHANIZATION DEVICE PROTOTYPES ...Design, Machinery, Equipment, Fish Meals, Shrimp, ...6.0051

DIMETHYLNITROSAMINE IN CURED, SMOKED WHITE FISH AND FLOUR BLEACHED WITH OXIDES OF NITROGEN ...Ethylene, Fish -other, Flour, Nitroso Compounds, Nitrous Oxide, ...6.0007

TOXIC IMPURITIES IN MARINE PROTEIN CONCENTRATE ...Food Spoilage -other, Infection, Intoxication & Pois, Toxic Substances snon-specific, Toxicological and Allergy, ...6.0009

Haddock

GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE 34 TO 50 F. ...Clostridium Botulinum, Food (epidemiology), Microbiological, Radiation, Temperature Control, ...6.0022

MARKET STRUCTURE OF COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST ...Commercial Fishing, Consumption, Market Structure, Northeast, Refrigeration, ...4.0186

Mackerel

COMPOSITION STUDIES OF FISH AND SHELLFISH AS RELATED TO STORAGE AND PROCESSING PROBLEMS ...Crabs, Fish -other, Freezing, Packaging, Rancidity, ...6.0046

Oysters

INOCULATED PACK STUDIES ON LOW-DOSE IRRADIATED MARINE PRODUCTS - SHRIMP ...Clostridium Botulinum, Microbiological, Radiation, Shrimp, ...6.0017

RADIATION PASTEURIZATION OF SHRIMP AND OYSTERS ...Iced Cooling and Storage, Organoleptic Studies, Radiation, Residues in Foods, Shrimp, ...6.0024

EVALUATION OF PRESENT AND PREPOSED LAWS REGULATING THE PROCESSING AND PACKING OF OYSTERS ...Food Processing -other, Legal Standards, Louisiana, Packaging, ...6.0027

OIL CONTAMINATION OF OYSTERS FROM OIL WELL DRILLING MUDS ...Fluid Properties, Infection, Intoxication & Pois, Oil, Oil and Natural Gas - Sulfur, Organoleptic Studies, ...5.0431

CHEMICAL AND MICROBIOLOGICAL APPLICATIONS TO PRODUCT ENGINEERING ...Design, Machinery, Equipment, Freezing, Iced Cooling and Storage, Microbiological, Shrimp, ...6.0050

INCIDENCE OF BACTERIA OF PUBLIC HEALTH SIGNIFICANCE IN FRESH COMMERCIAL SHELLFISH ...Coliforms (non-specific), Crabs, Microbiological, Radiation, Salmonella (non-specific & Ot), Staphylococcus (non-spec.& Ot), ...6.0038

Salmon

CHARACTERISTICS OF CANNED SALMON ...Legal Standards, Organoleptic Studies, ...6.0013

Shad

DEVELOPMENT OF NEW HUMAN FOOD PRODUCTS FROM SHAD ...Fish & Shellfish, Processing, Sausage and Variety Meats, Shelf Life & Storage, Smoking, ...6.0065

DEVELOPMENT OF THE SHAD INDUSTRY ...Fish & Shellfish, ...6.0064

Shellfish -non-specific

DETERMINATION OF THE STRUCTURE & ECONOMIC IMPORTANCE OF THE VARIOUS SEGMENTS OF THE SEAFOOD INDUSTRY ...Commercial Fishing, Consumer Pref. & Consumption, Fish & Shellfish, Fish -non-specific, Georgia, Production & Processing, Regional Economic Impact, ...4.0180

ESTIMATING THE VALUE ADDED TO SEAFOOD PRODUCTS LANDED IN GEORGIA AT THE VARIOUS STAGES OF THE MARKETING CHANNEL ...Fish -non-specific, Georgia, Processing, Quality -non-specific, ...6.0020

MICROFLORA OF RADIATION PASTEURIZED SEAFOODS ...Microbiological, Organoleptic Studies, Radiation, Radiation Sensitivity-, Refrigeration, ...6.0171

INVESTIGATE THE EFFECT OF IRRADIATION ON THE MICROBIAL FLORA SURVIVING IRRADIATION PASTEURIZATION OF SEAFOODS ...Consumer Pref. & Consumption, Food Spoilage Detection, Microbiological, Radiation, Radiation Protectors, ...6.0072

LABORATORY SCALE INVESTIGATION INTO THE FEASIBILITY OF RADIOPASTEURIZING FISH PRODUCTS ...Chemical Analysis, Microbiological, Organoleptic Studies, Radiation, Shelf Life & Storage, ...6.0035

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INOCULATED PACK STUDIES ON LOW-DOSE IRRADIATED MARINE PRODUCTS - SHRIMP ...Clostridium Botulinum, Microbiological, Oysters, Radiation, ...6.0017

RADIATION PASTEURIZATION OF SHRIMP AND OYSTERS ...Iced Cooling and Storage, Organoleptic Studies, Oysters, Radiation, Residues in Foods, ...6.0024

COMMERCIAL IRRADIATION OF SHELLFISH WITH A PORTABLE SHIPBOARD IRRADIATOR ...Chemical Analysis, Microbiological, Organoleptic Studies, Radiation, Shelf Life & Storage, ...6.0025

CAUSES AND PREVENTION OF UNDESIRABLE CHANGES IN THE QUALITY OF FRESH AND FROZEN GULF SHRIMP IN REFRIGERATED STORAGE ...Freezing, Radiation, Refrigeration, Shelf Life & Storage, ...6.0026

CHEMICAL REACTIONS IN PROCESSED SEAFOODS ...Enzymatic, Iced Cooling and Storage, Organoleptic Studies, Protein, ...6.0048

PROCESSING ALASKA SHRIMP ...Carotenoid Pigments, Design, Machinery, Equipment, Heat, Organoleptic Studies, Temperature Control, ...6.0002

OCEAN ENGINEERING ...Alaska, Commercial Fishing, Design, Machinery, Equipment, Fishing Gear, ...5.0349

CHEMICAL AND MICROBIOLOGICAL APPLICATIONS TO PRODUCT ENGINEERING ...Design, Machinery, Equipment, Freezing, Iced Cooling and Storage, Microbiological, Oysters, ...6.0050

CONTAINERIZATION OF FISHERY PRODUCTS ...Commercial Fishing, Fish -other, Packaging, Processing, ...6.0049

DEVELOPMENT OF MECHANIZATION DEVICE PROTOTYPES ...Design, Machinery, Equipment, Fish Meals, Fish Protein Concentrate, ...6.0051

INVESTIGATION OF DECOMPOSITION IN SHRIMP ...Ammonium, Food Spoilage Detection, Physical Decomposition, ...6.0011

INVESTIGATION OF THE PRESERVATION OF FOODS BY FREEZE DRYING ...Beef, Food Spoilage Detection, Freeze Drying, Legal Standards, Physical Decomposition, ...6.0012

Food Additives

Anti-oxidants

LIPID OXIDATION AND ASSOCIATED BIOCHEMICAL CHANGES OCCURRING DURING THE PROCESSING AND STORAGE OF FISHERY PRODUCTS ...Chemical Analysis, Fats, Fish -non-specific, Food Spoilage Detection, Rancidity, ...6.0071

DEVELOPMENT OF RADIATION STERILIZED FISH ITEMS FOR ARMED FORCES FEEDING ...Chemical Analysis, Consumer Pref. & Consumption, Fish -non-specific, Military Rations, Radiation, ...6.0073

THE COMPOSITION, NUTRITIVE VALUE AND QUALITY OF FISHERY PRODUCTS WITH SPECIAL EMPHASIS ON LIPID AND ITS INTERACTION ...Fats, Fats - Lipids, Fish -non-specific, Radiation, Unsaturated Fats, ...6.0076

UTILIZATION OF HAKE, DOGFISH, AND BY-PRODUCTS OF THE FILLET INDUSTRY FOR PROTEIN SUPPLEMENTS ...Chemical and Spices, Fish -other, Fish Protein Concentrate, Heat, Nutritive Value, Supplements, ...6.0067

Food Additives -other

THE EFFECT OF PROCESSING VARIABLES ON THE QUALITY OF MEAT FROM THE BLUE CRAB - CALLINECTES SAPIDUS ...Crabs, Heat, Organoleptic Studies, ...6.0061

DEVELOPMENT OF THE SHAD INDUSTRY ...Fish & Shellfish, ...6.0064

Preservatives

SURVIVAL MECHANISM OF IRRADIATED MICROORGANISMS IN FOOD ...Antibiotics, Cell Injury and Autolysis, Radiation, Radiation Protectors, Salmonella (non-specific & Ot), ...6.0070

Radiation Protectors

INVESTIGATE THE EFFECT OF IRRADIATION ON THE MICROBIAL FLORA SURVIVING IRRADIATION PASTEURIZATION OF SEAFOODS ...Consumer Pref. & Consumption, Food Spoilage Detection, Microbiological, Radiation, Shellfish -non-specific, ...6.0072

SURVIVAL MECHANISM OF IRRADIATED MICROORGANISMS IN FOOD ...Antibiotics, Cell Injury and Autolysis, Preservatives, Radiation, Salmonella (non-specific & Ot), ...6.0070

Food Chemistry

Amino Acids

BIOCHEMISTRY OF FISH AS RELATED TO HUMAN NUTRITION ...Hypoxanthine, Northeast, ...6.0053

Carbohydrates

STORAGE STABILITY STUDIES ON RADIATION STERILIZED FISH ITEMS ...Fats, Fish -non-specific, Freezing, Protein, Radiation, ...6.0074

Enzymes

FUNDAMENTAL STUDIES IN THE FLAVOR AND ODOR CHEMISTRY OF FISH PRODUCTS ...Fish -non-specific, Food Spoilage Detection, Microbiological, Organoleptic Studies, Radiation, ...6.0042

Fats

STABILITY OF FOOD LIPIDS TO IONIZING RADIATION ...Radiation, ...6.0029

LIPID OXIDATION AND ASSOCIATED BIOCHEMICAL CHANGES OCCURRING DURING THE PROCESSING AND STORAGE OF FISHERY PRODUCTS ...Anti-oxidants, Chemical Analysis, Fish -non-specific, Food Spoilage Detection, Rancidity, ...6.0071

THE COMPOSITION, NUTRITIVE VALUE AND QUALITY OF FISHERY PRODUCTS WITH SPECIAL EMPHASIS ON LIPID AND ITS INTERACTION ...Anti-oxidants, Fats - Lipids, Fish -non-specific, Radiation, Unsaturated Fats, ...6.0076

STORAGE STABILITY STUDIES ON RADIATION STERILIZED FISH ITEMS ...Carbohydrates, Fish -non-specific, Freezing, Protein, Radiation, ...6.0074

CHEMISTRY OF FISH OILS AND THEIR UTILIZATION ...Fats and Oils -other, Fish & Shellfish, Fish -non-specific, Oilseed Processing Technology, ...6.0082

EFFECTS OF IONIZING RADIATION ON FOOD LIPIDS ...Animal Fats -non-specific, Fish -non-specific, Organoleptic Studies, Radiation, ...6.0030

Physical and Chemical Change

INVESTIGATION OF FOOD PRESERVATION METHODS ...Chemical Analysis, Fish -other, Food Processing -other, Food Spoilage -other, Organoleptic Studies, ...6.0016

Protein

PREPARATION OF FISH PROTEIN HYDROLYSATES ...Analysis of Foods, Chemical Analysis, Fish -non-specific, Fish Protein Concentrate, Heat, ...6.0066

EFFECT OF STORAGE ON FISH MUSCLE PROTEINS ...Fish & Shellfish, Fish -non-specific, Food Raw Quality, Muscle Proteins, Organoleptic Studies, ...6.0062

STORAGE STABILITY STUDIES ON RADIATION STERILIZED FISH ITEMS ...Carbohydrates, Fats, Fish -non-specific, Freezing, Radiation, ...6.0074

CHEMICAL REACTIONS IN PROCESSED SEAFOODS ...Enzymatic, Iced Cooling and Storage, Organoleptic Studies, Shrimp, ...6.0048

Vitamins

ISOLATION OF ANTI-THIAMINE FACTORS IN HAWAII FISH ...Fish -non-specific, Food Spoilage Detection, Radiation, Thiamine, Thiamine Compounds, ...5.0261

Food Engineering & Technology

Design, Machinery, Equipment

MARKETING EFFICIENCY IN A COOPERATIVE FOOD-FISH PROCESSING PLANT, A CASE STUDY ...Fish & Shellfish, Fish -non-specific, Freezing, Processing, Shelf Life & Storage, ...6.0079

PROCESS ENGINEERING ...Esters, Extraction, Fats and Oils -other, Fish Protein Concentrate, Industrial Operation, Legal Standards, Natural Occurring, ...6.0080

PROCESSING ALASKA SHRIMP ...Carotenoid Pigments, Heat, Organoleptic Studies, Shrimp, Temperature Control, ...6.0002

OCEAN ENGINEERING ...Alaska, Commercial Fishing, Fishing Gear, Shrimp, ...5.0349

CHEMICAL AND MICROBIOLOGICAL APPLICATIONS TO PRODUCT ENGINEERING ...Freezing, Iced Cooling and Storage, Microbiological, Oysters, Shrimp, ...6.0050

DEVELOPMENT OF MECHANIZATION DEVICE PROTOTYPES ...Fish Meals, Fish Protein Concentrate, Shrimp, ...6.0051

PRODUCT/PROCESSING DEVELOPMENT RESEARCH ...Fish & Shellfish, Fish -non-specific, Freezing, Radiation, Refrigeration, ...5.0988

Packaging

EVALUATION OF PRESENT AND PREPOSED LAWS REGULATING THE PROCESSING AND PACKING OF OYSTERS ...Food Processing -other, Legal Standards, Louisiana, Oysters, ...6.0027

PRESERVATION AND DEVELOPMENT OF FOOD PRODUCTS ...Fish & Shellfish, Fish -non-specific, Food Raw Quality, Food Transport -other, Processed Product Quality, ...6.0084

COMPOSITION STUDIES OF FISH AND SHELLFISH AS RELATED TO STORAGE AND PROCESSING PROBLEMS ...Crabs, Fish -other, Freezing, Mackerel, Rancidity, ...6.0046

FUNDAMENTAL RADIATION CHEMISTRY RESEARCH ...Antibiotics, Chemical Analysis, Fish -non-specific, Radiation, Radiochemical Analysis, ...6.0040

CONTAINERIZATION OF FISHERY PRODUCTS ...Commercial Fishing, Fish -other, Processing, Shrimp, ...6.0049

PROCESSING AND PRODUCT DEVELOPMENT OF EDIBLE FISH AND SHELLFISH ...Commercial Fishing, Fish & Shellfish, ...6.0047

Food Needs and Demand

ANALYZING THE FACTORS AFFECTING THE DEMAND FOR SEAFOOD AND TO PROJECT THIS DEMAND TO FUTURE TIME PERIODS ...Consumer Pref. & Consumption, Fish -non-specific, Trends,projections, ...6.0021

Infection, Intoxication & Pois

OIL CONTAMINATION OF OYSTERS FROM OIL WELL DRILLING MUDS ...Fluid Properties, Oil, Oil and Natural Gas - Sulfur, Organoleptic Studies, Oysters, ...5.0431

TOXIC IMPURITIES IN MARINE PROTEIN CONCENTRATE ...Fish Protein Concentrate, Food Spoilage -other, Toxic Substances -non-specific, Toxicological and Allergy, ...6.0009

ELECTROPHORETIC PROFILES FOR THE IDENTIFICATION OF FISH SPECIES ...Disc Electrophoresis, Fish -non-specific, Gel Electrophoresis, Legal Standards, ...6.0014

PROGRAM PROJECT - FOOD MICROBIOLOGY ...Clostridia (non-specific & Ot), Food (epidemiology), Microbiological, Salmonella (non-specific & Ot), Toxicological and Allergy, ...6.0005

Meats and Meat Product

Beef

INVESTIGATION OF THE PRESERVATION OF FOODS BY FREEZE DRYING ...Food Spoilage Detection, Freeze Drying, Legal Standards, Physical Decomposition, Shrimp, ...6.0012

Meat -non-specific

ANALYSIS OF THE DEMAND FOR RED MEAT, POULTRY, EGGS, SEAFOOD, AND MEAT MIXTURES ...Consumer Pref. & Consumption, Eggs, Fish -non-specific, Price & Value, ...6.0019

Sausage and Variety Meats

DEVELOPMENT OF NEW HUMAN FOOD PRODUCTS FROM SHAD ...Fish & Shellfish, Processing, Shad, Shelf Life & Storage, Smoking, ...6.0065

Military Rations

DEVELOPMENT OF RADIATION STERILIZED FISH ITEMS FOR ARMED FORCES FEEDING ...Anti-oxidants, Chemical Analysis, Consumer Pref. & Consumption, Fish -non-specific, Radiation, ...6.0073

Nuts & Nutmeats

Peanuts

FERMENTED PROTEIN-RICH FOODS ...Fermentation, Malting, Fish -non-specific, Fungal Toxins, Milk, Soybeans, ...6.0055

Processing & Preservation

Antibiotics

BOTULINUM FOOD POISONING IN RELATION TO FISHERY PRODUCTS ...Clostridium Botulinum, Fish -non-specific, Great Lakes-general, Microbiological, Repression, ...6.0087

SURVIVAL MECHANISM OF IRRADIATED BACTERIA IN FOODS ...Achromobacter Sp, Cell Injury and Autolysis, Fish -non-specific, Mutagens, Radiation, ...6.0069

FUNDAMENTAL RADIATION CHEMISTRY RESEARCH ...Chemical Analysis, Fish -non-specific, Packaging, Radiation, Radiochemical Analysis, ...**6.0040**

SURVIVAL MECHANISM OF IRRADIATED MICROORGANISMS IN FOOD ...Cell Injury and Autolysis, Preservatives, Radiation, Radiation Protectors, Salmonella (non-specific & Ot), ...**6.0070**

Chemical and Spices

UTILIZATION OF HAKE, DOGFISH, AND BY-PRODUCTS OF THE FILLET INDUSTRY FOR PROTEIN SUPPLEMENTS ...Anti-oxidants, Fish -other, Fish Protein Concentrate, Heat, Nutritive Value, Supplements, ...**6.0067**

Fermentation, Malting

ANTIOXIDANT AND NUTRITIONAL POTENTIAL OF FERMENTED AND UNFERMENTED SOYBEANS IN COMBINATION WITH FISH ...Fish -non-specific, Food Spoilage Detection, Proteins, Rancidity, Soybeans, ...**6.0023**

FERMENTED PROTEIN-RICH FOODS ...Fish -non-specific, Fungal Toxins, Milk, Peanuts, Soybeans, ...**6.0055**

Food Processing -other

EVALUATION OF PRESENT AND PREPOSED LAWS REGULATING THE PROCESSING AND PACKING OF OYSTERS ...Legal Standards, Louisiana, Oysters, Packaging, ...**6.0027**

VITAMIN K5 AS A FOOD PRESERVATIVE ...Food Bacteria, Microbiological, Repression, Vitamin K, ...**6.0075**

DEVELOPMENT OF THE SHAD INDUSTRY ...Fish & Shellfish, ...**6.0064**

INVESTIGATION OF FOOD PRESERVATION METHODS ...Chemical Analysis, Fish -other, Food Spoilage -other, Organoleptic Studies, Physical and Chemical Change, ...**6.0016**

Freeze Drying

INVESTIGATION OF THE PRESERVATION OF FOODS BY FREEZE DRYING ...Beef, Food Spoilage Detection, Legal Standards, Physical Decomposition, Shrimp, ...**6.0012**

Freezing

CAUSES AND PREVENTION OF UNDESIRABLE CHANGES IN THE QUALITY OF FRESH AND FROZEN GULF SHRIMP IN REFRIGERATED STORAGE ...Radiation, Refrigeration, Shelf Life & Storage, Shrimp, ...**6.0026**

STORAGE STABILITY STUDIES ON RADIATION STERILIZED FISH ITEMS ...Carbohydrates, Fats, Fish -non-specific, Protein, Radiation, ...**6.0074**

MARKETING EFFICIENCY IN A COOPERATIVE FOOD-FISH PROCESSING PLANT, A CASE STUDY ...Design, Machinery, Equipment, Fish & Shellfish, Fish -non-specific, Processing, Shelf Life & Storage, ...**6.0079**

PROCESSING KING CRAB ...Commercial Fishing, Crabs, Fish & Shellfish, Fish Meals, Organoleptic Studies, ...**6.0003**

CHEMICAL AND MICROBIOLOGICAL APPLICATIONS TO PRODUCT ENGINEERING ...Design, Machinery, Equipment, Iced Cooling and Storage, Microbiological, Oysters, Shrimp, ...**6.0050**

COMPOSITION STUDIES OF FISH AND SHELLFISH AS RELATED TO STORAGE AND PROCESSING PROBLEMS ...Crabs, Fish -other, Mackerel, Packaging, Rancidity, ...**6.0046**

PRODUCT/PROCESSING DEVELOPMENT RESEARCH ...Design, Machinery, Equipment, Fish & Shellfish, Fish -non-specific, Radiation, Refrigeration, ...**5.0988**

CONTROL OF OXIDATIVE CHANGES IN FRESHWATER FISH ...Chemical Analysis, Fish -non-specific, Fresh Water, Organoleptic Studies, Rancidity, ...**6.0045**

Heat

PREPARATION OF FISH PROTEIN HYDROLYSATES ...Analysis of Foods, Chemical Analysis, Fish -non-specific, Fish Protein Concentrate, Protein, ...**6.0066**

THE EFFECT OF PROCESSING VARIABLES ON THE QUALITY OF MEAT FROM THE BLUE CRAB - CALLINECTES SAPIDUS ...Crabs, Food Additives -other, Organoleptic Studies, ...**6.0061**

UTILIZATION OF HAKE, DOGFISH, AND BY-PRODUCTS OF THE FILLET INDUSTRY FOR PROTEIN SUPPLEMENTS ...Anti-oxidants, Chemical and Spices, Fish -other, Fish Protein Concentrate, Nutritive Value, Supplements, ...**6.0067**

PROCESSING ALASKA SHRIMP ...Carotenoid Pigments, Design, Machinery, Equipment, Organoleptic Studies, Shrimp, Temperature Control, ...**6.0002**

PROCESS-INDUCED CHANGES IN CRUSTACEAN MUSCLE TISSUE ...Crabs, Nucleotides -non-specific, Organoleptic Studies, ...**5.0350**

COMPOSITION OF BREADED FISH PRODUCTS ...Fish -non-specific, Food Preparation, Legal Standards, ...**6.0015**

Iced Cooling and Storage

RADIATION PASTEURIZATION OF SHRIMP AND OYSTERS ...Organoleptic Studies, Oysters, Radiation, Residues in Foods, Shrimp, ...**6.0024**

THE STORAGE LIFE OF ICED DEEP SEA RED CRABS - GERYON QUINQUEDENS ...Crabs, Microbiological, Organoleptic Studies, Shelf Life & Storage, ...**6.0077**

CHEMICAL REACTIONS IN PROCESSED SEAFOODS ...Enzymatic, Organoleptic Studies, Protein, Shrimp, ...**6.0048**

CHEMICAL AND MICROBIOLOGICAL APPLICATIONS TO PRODUCT ENGINEERING ...Design, Machinery, Equipment, Freezing, Microbiological, Oysters, Shrimp, ...**6.0050**

Oilseed Processing Technology

CHEMISTRY OF FISH OILS AND THEIR UTILIZATION ...Fats, Fats and Oils -other, Fish & Shellfish, Fish -non-specific, ...**6.0082**

Radiation

FUNDAMENTAL STUDIES IN THE FLAVOR AND ODOR CHEMISTRY OF FISH PRODUCTS ...Enzymes, Fish -non-specific, Food Spoilage Detection, Microbiological, Organoleptic Studies, ...**6.0042**

OUTGROWTH OF CLOSTRIDIUM BOTULINUM TYPE E IN NONIRRADIATED AND IRRADIATED FISHERY PRODUCTS ...Clostridium Botulinum, Fish -non-specific, Food (epidemiology), Microbiological, Refrigeration, ...**6.0081**

THE EVALUATION OF WHOLESOMENESS OF RADIATION SUB-STERILIZED FOOD PRODUCTS USING RATS ...Animal Protein, Clams, Laboratory Rat, Quantitative & Qualitative, Thiaminase, ...**6.0031**

GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE 34 TO 50 F. ...Clostridium Botulinum, Food (epidemiology), Haddock, Microbiological, Temperature Control, ...**6.0022**

STABILITY OF FOOD LIPIDS TO IONIZING RADIATION ...Fats, ...**6.0029**

STUDY OF THE BASIC MICROBIOLOGICAL AND BIOCHEMICAL FACTORS IN THE IRRADIATION PRESERVATION OF MARINE PRODUCTS ...Bacteria, Fish -non-specific, Microbiological, Refrigeration, Staphylococcus (non-spec.& Ot), ...**6.0085**

INOCULATED PACK STUDIES ON LOW-DOSE IRRADIATED MARINE PRODUCTS - SHRIMP ...Clostridium Botulinum, Microbiological, Oysters, Shrimp, ...**6.0017**

RADIOPASTEURIZATION OF FISHERY PRODUCTS-OPERATION AND DEVELOPMENTAL INVESTIGATIONS ...Chemical Analysis, Fish -non-specific, Microbiological, Organoleptic Studies, Shelf Life & Storage, ...**6.0033**

RADIATION PASTEURIZATION OF SHRIMP AND OYSTERS ...Iced Cooling and Storage, Organoleptic Studies, Oysters, Residues in Foods, Shrimp, ...**6.0024**

COMMERCIAL IRRADIATION OF SHELLFISH WITH A PORTABLE SHIPBOARD IRRADIATOR ...Chemical Analysis, Microbiological, Organoleptic Studies, Shelf Life & Storage, Shrimp, ...**6.0025**

APPLICATION OF RADIATION PASTEURIZATION PROCESSES TO PACIFIC CRAB AND FLOUNDER ...Clostridium Botulinum, Fish -non-specific, Microbiological, Processing, Toxicological and Allergy, ...**6.0083**

RADIATION PRESERVATION OF FISHERY PRODUCTS ...Commercial Fishing, Fish & Shellfish, Fish -non-specific, Organoleptic Studies, Shelf Life & Storage, ...**6.0034**

CAUSES AND PREVENTION OF UNDESIRABLE CHANGES IN THE QUALITY OF FRESH AND FROZEN GULF SHRIMP IN REFRIGERATED STORAGE ...Freezing, Refrigeration, Shelf Life & Storage, Shrimp, ...**6.0026**

MICROFLORA OF RADIATION PASTEURIZED SEAFOODS ...Microbiological, Organoleptic Studies, Radiation Sensitivity-, Refrigeration, Shellfish -non-specific, ...**6.0171**

INVESTIGATE THE EFFECT OF IRRADIATION ON THE MICROBIAL FLORA SURVIVING IRRADIATION PASTEURIZATION OF SEAFOODS ...Consumer Pref. & Consumption, Food Spoilage Detection, Microbiological, Radiation Protectors, Shellfish -non-specific, ...**6.0072**

DEVELOPMENT OF RADIATION STERILIZED FISH ITEMS FOR ARMED FORCES FEEDING ...Anti-oxidants, Chemical Analysis, Consumer Pref. & Consumption, Fish -non-specific, Military Rations, ...6.0073

THE COMPOSITION, NUTRITIVE VALUE AND QUALITY OF FISHERY PRODUCTS WITH SPECIAL EMPHASIS ON LIPID AND ITS INTERACTION ...Anti-oxidants, Fats, Fats - Lipids, Fish -non-specific, Unsaturated Fats, ...6.0076

SURVIVAL MECHANISM OF IRRADIATED BACTERIA IN FOODS ...Achromobacter Sp, Antibiotics, Cell Injury and Autolysis, Fish -non-specific, Mutagens, ...6.0069

STORAGE STABILITY STUDIES ON RADIATION STERILIZED FISH ITEMS ...Carbohydrates, Fats, Fish -non-specific, Freezing, Protein, ...6.0074

LABORATORY SCALE INVESTIGATION INTO THE FEASIBILITY OF RADIOPASTEURIZING FISH PRODUCTS ...Chemical Analysis, Microbiological, Organoleptic Studies, Shelf Life & Storage, Shellfish -non-specific, ...6.0035

IRRADIATION SERVICES AND STUDIES ...Fish & Shellfish, Fish -non-specific, Instrumental Services, ...6.0036

COMMERCIAL BENEFIT STUDIES ...Commercial Fishing, Fish & Shellfish, ...6.0037

INCIDENCE OF BACTERIA OF PUBLIC HEALTH SIGNIFICANCE IN FRESH COMMERCIAL SHELLFISH ...Coliforms (non-specific), Crabs, Microbiological, Oysters, Salmonella (non-specific & Ot), Staphylococcus (non-spec.& Ot), ...6.0038

SHIPBOARD IRRADIATION STUDIES ...Fish -non-specific, Food Raw Quality, Medical Studies, Microbiological, Shelf Life & Storage, ...6.0039

FUNDAMENTAL RADIATION CHEMISTRY RESEARCH ...Antibiotics, Chemical Analysis, Fish -non-specific, Packaging, Radiochemical Analysis, ...6.0040

INVESTIGATION OF FEASIBILITY OF STERILIZING FISH BY RADIATION ...Enzymatic, Fish -non-specific, Inactivation, Organoleptic Studies, Shelf Life & Storage, ...6.0041

PROCESSING AND PRODUCT DEVELOPMENT OF EDIBLE FISH AND SHELLFISH ...Commercial Fishing, Fish & Shellfish, ...6.0047

PRODUCT/PROCESSING DEVELOPMENT RESEARCH ...Design, Machinery, Equipment, Fish & Shellfish, Fish -non-specific, Freezing, Refrigeration, ...5.0988

SURVIVAL OF FOOD PATHOGENS IN RADIATION PASTEURIZATION SEAFOOD ...Cell. env.(non-specific & Ot.), Cobalt, Crabs, Food Bacteria, Radiation Sensitivity-, ...6.0063

SURVIVAL MECHANISM OF IRRADIATED MICROORGANISMS IN FOOD ...Antibiotics, Cell Injury and Autolysis, Preservatives, Radiation Protectors, Salmonella (non-specific & Ot), ...6.0070

EFFECTS OF IONIZING RADIATION ON FOOD LIPIDS ...Animal Fats -non-specific, Fats, Fish -non-specific, Organoleptic Studies, ...6.0030

ISOLATION OF ANTI-THIAMINE FACTORS IN HAWAII FISH ...Fish -non-specific, Food Spoilage Detection, Thiamine, Thiamine Compounds, Vitamins, ...5.0261

Refrigeration

OUTGROWTH OF CLOSTRIDIUM BOTULINUM TYPE E IN NONIRRADIATED AND IRRADIATED FISHERY PRODUCTS ...Clostridium Botulinum, Fish -non-specific, Food (epidemiology), Microbiological, Radiation, ...6.0081

STUDY OF THE BASIC MICROBIOLOGICAL AND BIOCHEMICAL FACTORS IN THE IRRADIATION PRESERVATION OF MARINE PRODUCTS ...Bacteria, Fish -non-specific, Microbiological, Radiation, Staphylococcus (non-spec.& Ot), ...6.0085

MARKET STRUCTURE OF COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST ...Commercial Fishing, Consumption, Haddock, Market Structure, Northeast, ...4.0186

CAUSES AND PREVENTION OF UNDESIRABLE CHANGES IN THE QUALITY OF FRESH AND FROZEN GULF SHRIMP IN REFRIGERATED STORAGE ...Freezing, Radiation, Shelf Life & Storage, Shrimp, ...6.0026

MICROFLORA OF RADIATION PASTEURIZED SEAFOODS ...Microbiological, Organoleptic Studies, Radiation, Radiation Sensitivity-, Shellfish -non-specific, ...6.0171

PRODUCT/PROCESSING DEVELOPMENT RESEARCH ...Design, Machinery, Equipment, Fish & Shellfish, Fish -non-specific, Freezing, Radiation, ...5.0988

LOW TEMPERATURE GROWTH OF BACTERIA ON FOODS ...Cryophilic Bacteria, Fish -non-specific, Growth (non-specific & Ot.), Isoenzymes, Microbiological, Temperature, ...6.0086

Smoking

DEVELOPMENT OF NEW HUMAN FOOD PRODUCTS FROM SHAD ...Fish & Shellfish, Processing, Sausage and Variety Meats, Shad, Shelf Life & Storage, ...6.0065

CONSUMER EVALUATION OF FISH PRODUCTS ...Consumer Pref. & Consumption, Fish & Shellfish, Fish -non-specific, Organoleptic Studies, ...6.0004

DISTRIBUTION OF C. BOTULINUM IN COMMERCIAL SMOKED FISH ...Bacterial Pollutant Sources, Clostridium Botulinum, Fish -non-specific, Food (epidemiology), Microbiological, ...5.0337

EFFECTS OF HANDLING AND PROCESSING PROCEDURES IN POTENTIAL PATHOGENUS ON FISH ...Clostridium Botulinum, Fish -other, Legal Standards, Microbiological, Toxicological and Allergy, ...6.0044

RADIOCHEMICAL TECHNIQUES ...Food Spoilage Detection, Mercury, Polonium, Radioactive Isotopes, Wheat, ...6.0008

Temperature Control

GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE 34 TO 50 F. ...Clostridium Botulinum, Food (epidemiology), Haddock, Microbiological, Radiation, ...6.0022

PROCESSING ALASKA SHRIMP ...Carotenoid Pigments, Design, Machinery, Equipment, Heat, Organoleptic Studies, Shrimp, ...6.0002

Proteins

Animal Protein

THE EVALUATION OF WHOLESOMENESS OF RADIATION SUB-STERILIZED FOOD PRODUCTS USING RATS ...Clams, Laboratory Rat, Quantitative & Qualitative, Radiation, Thiaminase, ...6.0031

Quality Control and Standards

Food Raw Quality

EFFECT OF STORAGE ON FISH MUSCLE PROTEINS ...Fish & Shellfish, Fish -non-specific, Muscle Proteins, Organoleptic Studies, Protein, ...6.0062

BIOCHEMISTRY OF FISH MUSCLE AND QUALITY CHANGES ...Enzymatic, Fish -non-specific, Muscle, Organoleptic Studies, ...5.1035

PRESERVATION AND DEVELOPMENT OF FOOD PRODUCTS ...Fish & Shellfish, Fish -non-specific, Food Transport -other, Packaging, Processed Product Quality, ...6.0084

SHIPBOARD IRRADIATION STUDIES ...Fish -non-specific, Medical Studies, Microbiological, Radiation, Shelf Life & Storage, ...6.0039

Legal Standards

QUALITY STANDARDS TO DETERMINE RELEASE OF SHELLFISH FOR MARKETING PURPOSES ...Clams, Microbiological, Sanitation, Shelf Life & Storage, ...6.0166

EVALUATION OF PRESENT AND PREPOSED LAWS REGULATING THE PROCESSING AND PACKING OF OYSTERS ...Food Processing -other, Louisiana, Oysters, Packaging, ...6.0027

PROCESS ENGINEERING ...Design, Machinery, Equipment, Esters, Extraction, Fats and Oils -other, Fish Protein Concentrate, Industrial Operation, Natural Occurring, ...6.0080

EFFECTS OF HANDLING AND PROCESSING PROCEDURES IN POTENTIAL PATHOGENUS ON FISH ...Clostridium Botulinum, Fish -other, Microbiological, Smoking, Toxicological and Allergy, ...6.0044

CHARACTERISTICS OF CANNED SALMON ...Organoleptic Studies, Salmon, ...6.0013

ELECTROPHORETIC PROFILES FOR THE IDENTIFICATION OF FISH SPECIES ...Disc Electrophoresis, Fish -non-specific, Gel Electrophoresis, Infection, Intoxication & Pois, ...6.0014

COMPOSITION OF BREADED FISH PRODUCTS ...Fish -non-specific, Food Preparation, Heat, ...6.0015

BACTERIOLOGICAL SURVEYS FOR MICROBIAL STANDARDS FOR FOOD ...Crabs, Escherichia Coli, Food Spoilage Detection, Microbiological, Staphylococcus (non-spec.& Ot), ...6.0010

INVESTIGATION OF THE PRESERVATION OF FOODS BY FREEZE DRYING ...Beef, Food Spoilage Detection, Freeze Drying, Physical Decomposition, Shrimp, ...6.0012

Nutritive Value

NUTRITIVE VALUE OF FISH AND OTHER MARINE PRODUCTS ...Ascorbic Acid, Fish -non-specific, Paper Chromatography, Proteins -non-specific, Thiamine, ...6.0054

UTILIZATION OF HAKE, DOGFISH, AND BY-PRODUCTS OF THE FILLET INDUSTRY FOR PROTEIN SUPPLEMENTS ...Anti-oxidants, Chemical and Spices, Fish -other, Fish Protein Concentrate, Heat, Supplements, ...6.0067

UTILIZATION AND PREPARATION OF FISH PROTEIN CONCENTRATE ...Chemical Analysis, Fish & Shellfish, Fish Protein Concentrate, Organoleptic Studies, Proteins, ...6.0125

Organoleptic Studies

FUNDAMENTAL STUDIES IN THE FLAVOR AND ODOR CHEMISTRY OF FISH PRODUCTS ...Enzymes, Fish -non-specific, Food Spoilage Detection, Microbiological, Radiation, ...6.0042

STABILITY OF FOOD LIPIDS TO IONIZING RADIATION ...Fats, Radiation, ...6.0029

RADIOPASTEURIZATION OF FISHERY PRODUCTS-OPERATION AND DEVELOPMENTAL INVESTIGATIONS ...Chemical Analysis, Fish -non-specific, Microbiological, Radiation, Shelf Life & Storage, ...6.0033

RADIATION PASTEURIZATION OF SHRIMP AND OYSTERS ...Iced Cooling and Storage, Oysters, Radiation, Residues in Foods, Shrimp, ...6.0024

COMMERCIAL IRRADIATION OF SHELLFISH WITH A PORTABLE SHIPBOARD IRRADIATOR ...Chemical Analysis, Microbiological, Radiation, Shelf Life & Storage, Shrimp, ...6.0025

RADIATION PRESERVATION OF FISHERY PRODUCTS ...Commercial Fishing, Fish & Shellfish, Fish -non-specific, Radiation, Shelf Life & Storage, ...6.0034

CONSUMER EVALUATION OF FISH PRODUCTS ...Consumer Pref. & Consumption, Fish & Shellfish, Fish -non-specific, Smoking, ...6.0004

OIL CONTAMINATION OF OYSTERS FROM OIL WELL DRILLING MUDS ...Fluid Properties, Infection, Intoxication & Pois, Oil, Oil and Natural Gas - Sulfur, Oysters, ...5.0431

THE EFFECT OF PROCESSING VARIABLES ON THE QUALITY OF MEAT FROM THE BLUE CRAB - CALLINECTES SAPIDUS ...Crabs, Food Additives -other, Heat, ...6.0061

EFFECT OF STORAGE ON FISH MUSCLE PROTEINS ...Fish & Shellfish, Fish -non-specific, Food Raw Quality, Muscle Proteins, Protein, ...6.0062

MICROFLORA OF RADIATION PASTEURIZED SEAFOODS ...Microbiological, Radiation, Radiation Sensitivity-, Refrigeration, Shellfish -non-specific, ...6.0171

DEVELOPMENT OF THE SHAD INDUSTRY ...Fish & Shellfish, ...6.0064

UTILIZATION AND PREPARATION OF FISH PROTEIN CONCENTRATE ...Chemical Analysis, Fish & Shellfish, Fish Protein Concentrate, Nutritive Value, Proteins, ...6.0125

THE STORAGE LIFE OF ICED DEEP SEA RED CRABS - GERYON QUINQUEDENS ...Crabs, Iced Cooling and Storage, Microbiological, Shelf Life & Storage, ...6.0077

CHEMICAL REACTIONS IN PROCESSED SEAFOODS ...Enzymatic, Iced Cooling and Storage, Protein, Shrimp, ...6.0048

BIOCHEMISTRY OF FISH MUSCLE AND QUALITY CHANGES ...Enzymatic, Fish -non-specific, Food Raw Quality, Muscle, ...5.1035

PROCESSING ALASKA SHRIMP ...Carotenoid Pigments, Design, Machinery, Equipment, Heat, Shrimp, Temperature Control, ...6.0002

PROCESS-INDUCED CHANGES IN CRUSTACEAN MUSCLE TISSUE ...Crabs, Heat, Nucleotides -non-specific, ...5.0350

PROCESSING KING CRAB ...Commercial Fishing, Crabs, Fish & Shellfish, Fish Meals, Freezing, ...6.0003

LABORATORY SCALE INVESTIGATION INTO THE FEASIBILITY OF RADIOPASTEURIZING FISH PRODUCTS ...Chemical Analysis, Microbiological, Radiation, Shelf Life & Storage, Shellfish -non-specific, ...6.0035

INVESTIGATION OF FEASIBILITY OF STERILIZING FISH BY RADIATION ...Enzymatic, Fish -non-specific, Inactivation, Radiation, Shelf Life & Storage, ...6.0041

CONTROL OF OXIDATIVE CHANGES IN FRESHWATER FISH ...Chemical Analysis, Fish -non-specific, Freezing, Fresh Water, Rancidity, ...6.0045

INVESTIGATION OF FOOD PRESERVATION METHODS ...Chemical Analysis, Fish -other, Food Processing -other, Food Spoilage -other, Physical and Chemical Change, ...6.0016

CHARACTERISTICS OF CANNED SALMON ...Legal Standards, Salmon, ...6.0013

EFFECTS OF IONIZING RADIATION ON FOOD LIPIDS ...Animal Fats -non-specific, Fats, Fish -non-specific, Radiation, ...6.0030

Processed Product Quality

EFFECT OF PROCESS ON SHELLFISH ...Clams, Processing, Sanitation, Shelf Life & Storage, Winter, ...6.0059

PRESERVATION AND DEVELOPMENT OF FOOD PRODUCTS ...Fish & Shellfish, Fish -non-specific, Food Raw Quality, Food Transport -other, Packaging, ...6.0084

Shelf Life & Storage

RADIOPASTEURIZATION OF FISHERY PRODUCTS-OPERATION AND DEVELOPMENTAL INVESTIGATIONS ...Chemical Analysis, Fish -non-specific, Microbiological, Organoleptic Studies, Radiation, ...6.0033

COMMERCIAL IRRADIATION OF SHELLFISH WITH A PORTABLE SHIPBOARD IRRADIATOR ...Chemical Analysis, Microbiological, Organoleptic Studies, Radiation, Shrimp, ...6.0025

RADIATION PRESERVATION OF FISHERY PRODUCTS ...Commercial Fishing, Fish & Shellfish, Fish -non-specific, Organoleptic Studies, Radiation, ...6.0034

DEVELOPMENT OF NEW HUMAN FOOD PRODUCTS FROM SHAD ...Fish & Shellfish, Processing, Sausage and Variety Meats, Shad, Smoking, ...6.0065

QUALITY STANDARDS TO DETERMINE RELEASE OF SHELLFISH FOR MARKETING PURPOSES ...Clams, Legal Standards, Microbiological, Sanitation, ...6.0166

EFFECT OF PROCESS ON SHELLFISH ...Clams, Processed Product Quality, Processing, Sanitation, Winter, ...6.0059

CAUSES AND PREVENTION OF UNDESIRABLE CHANGES IN THE QUALITY OF FRESH AND FROZEN GULF SHRIMP IN REFRIGERATED STORAGE ...Freezing, Radiation, Refrigeration, Shrimp, ...6.0026

THE STRUCTURE OF DECISION MAKING IN MAJOR MARKETING AGENCIES OF FOOD FISH IN THE N.E. UNITED STATES ...Fish -non-specific, Marketing, Northeast, Price & Value, Production & Processing, ...6.0078

MARKETING EFFICIENCY IN A COOPERATIVE FOOD-FISH PROCESSING PLANT, A CASE STUDY ...Design, Machinery, Equipment, Fish & Shellfish, Fish -non-specific, Freezing, Processing, ...6.0079

THE STORAGE LIFE OF ICED DEEP SEA RED CRABS - GERYON QUINQUEDENS ...Crabs, Iced Cooling and Storage, Microbiological, Organoleptic Studies, ...6.0077

LABORATORY SCALE INVESTIGATION INTO THE FEASIBILITY OF RADIOPASTEURIZING FISH PRODUCTS ...Chemical Analysis, Microbiological, Organoleptic Studies, Radiation, Shellfish -non-specific, ...6.0035

COMMERCIAL BENEFIT STUDIES ...Commercial Fishing, Fish & Shellfish, ...6.0037

SHIPBOARD IRRADIATION STUDIES ...Fish -non-specific, Food Raw Quality, Medical Studies, Microbiological, Radiation, ...6.0039

INVESTIGATION OF FEASIBILITY OF STERILIZING FISH BY RADIATION ...Enzymatic, Fish -non-specific, Inactivation, Organoleptic Studies, Radiation, ...6.0041

Spoilage

Enzymatic

STUDY OF THIAMINASE IN HAWAII FISH ...Enzyme Inhibitors, Fish -non-specific, Hawaii, Thiaminase, Toxicological and Allergy, ...5.0260

CHEMICAL REACTIONS IN PROCESSED SEAFOODS ...Iced Cooling and Storage, Organoleptic Studies, Protein, Shrimp, ...6.0048

BIOCHEMISTRY OF FISH MUSCLE AND QUALITY CHANGES ...Fish -non-specific, Food Raw Quality, Muscle, Organoleptic Studies, ...5.1035

INVESTIGATION OF FEASIBILITY OF STERILIZING FISH BY RADIATION ...Fish -non-specific, Inactivation, Organoleptic Studies, Radiation, Shelf Life & Storage, ...6.0041

Food Spoilage -other

INVESTIGATION OF FOOD PRESERVATION METHODS ...Chemical Analysis, Fish -other, Food Processing -other, Organoleptic Studies, Physical and Chemical Change, ...6.0016

TOXIC IMPURITIES IN MARINE PROTEIN CONCENTRATE ...Fish Protein Concentrate, Infection, Intoxication & Pois, Toxic Substances -non-specific, Toxicological and Allergy, ...6.0009

Food Spoilage Detection

FUNDAMENTAL STUDIES IN THE FLAVOR AND ODOR CHEMISTRY OF FISH PRODUCTS ...Enzymes, Fish -non-specific, Microbiological, Organoleptic Studies, Radiation, ...6.0042

BACTERIAL INDICATORS OF THE SANITARY QUALITY OF DEPURATED HARD CLAMS, MERCENARIA MERCENARIA ...Clams, Microbiological, Sanitation, ...6.0056

ANTIOXIDANT AND NUTRITIONAL POTENTIAL OF FERMENTED AND UNFERMENTED SOYBEANS IN COMBINATION WITH FISH ...Fermentation, Malting, Fish -non-specific, Proteins, Rancidity, Soybeans, ...6.0023

LIPID OXIDATION AND ASSOCIATED BIOCHEMICAL CHANGES OCCURRING DURING THE PROCESSING AND STORAGE OF FISHERY PRODUCTS ...Anti-oxidants, Chemical Analysis, Fats, Fish -non-specific, Rancidity, ...6.0071

INVESTIGATE THE EFFECT OF IRRADIATION ON THE MICROBIAL FLORA SURVIVING IRRADIATION PASTEURIZATION OF SEAFOODS ...Consumer Pref. & Consumption, Microbiological, Radiation, Radiation Protectors, Shellfish -non-specific, ...6.0072

RADIOCHEMICAL TECHNIQUES ...Mercury, Polonium, Radioactive Isotopes, Smoking, Wheat, ...6.0008

BACTERIOLOGICAL SURVEYS FOR MICROBIAL STANDARDS FOR FOOD ...Crabs, Escherichia Coli, Legal Standards, Microbiological, Staphylococcus (non-spec.& Ot), ...6.0010

INVESTIGATION OF DECOMPOSITION IN SHRIMP ...Ammonium, Physical Decomposition, Shrimp, ...6.0011

INVESTIGATION OF THE PRESERVATION OF FOODS BY FREEZE DRYING ...Beef, Freeze Drying, Legal Standards, Physical Decomposition, Shrimp, ...6.0012

ORGANISMS RESPONSIBLE FOR TOXICITY OF ALASKAN CLAMS ...Alaska, Biological Pollutants -general, Clams, Microbiological, Pollutants-general, ...5.0344

ISOLATION OF ANTI-THIAMINE FACTORS IN HAWAII FISH ...Fish -non-specific, Radiation, Thiamine, Thiamine Compounds, Vitamins, ...5.0261

Microbiological

FUNDAMENTAL STUDIES IN THE FLAVOR AND ODOR CHEMISTRY OF FISH PRODUCTS ...Enzymes, Fish -non-specific, Food Spoilage Detection, Organoleptic Studies, Radiation, ...6.0042

OUTGROWTH OF CLOSTRIDIUM BOTULINUM TYPE E IN NONIRRADIATED AND IRRADIATED FISHERY PRODUCTS ...Clostridium Botulinum, Fish -non-specific, Food (epidemiology), Radiation, Refrigeration, ...6.0081

GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE 34 TO 50 F. ...Clostridium Botulinum, Food (epidemiology), Haddock, Radiation, Temperature Control, ...6.0022

STUDY OF THE BASIC MICROBIOLOGICAL AND BIOCHEMICAL FACTORS IN THE IRRADIATION PRESERVATION OF MARINE PRODUCTS ...Bacteria, Fish -non-specific, Radiation, Refrigeration, Staphylococcus (non-spec.& Ot), ...6.0085

INOCULATED PACK STUDIES ON LOW-DOSE IRRADIATED MARINE PRODUCTS - SHRIMP ...Clostridium Botulinum, Oysters, Radiation, Shrimp, ...6.0017

RADIOPASTEURIZATION OF FISHERY PRODUCTS-OPERATION AND DEVELOPMENTAL INVESTIGATIONS ...Chemical Analysis, Fish -non-specific, Organoleptic Studies, Radiation, Shelf Life & Storage, ...6.0033

COMMERCIAL IRRADIATION OF SHELLFISH WITH A PORTABLE SHIPBOARD IRRADIATOR ...Chemical Analysis, Organoleptic Studies, Radiation, Shelf Life & Storage, Shrimp, ...6.0025

APPLICATION OF RADIATION PASTEURIZATION PROCESSES TO PACIFIC CRAB AND FLOUNDER ...Clostridium Botulinum, Fish -non-specific, Processing, Radiation, Toxicological and Allergy, ...6.0083

BACTERIAL INDICATORS OF THE SANITARY QUALITY OF DEPURATED HARD CLAMS, MERCENARIA MERCENARIA ...Clams, Food Spoilage Detection, Sanitation, ...6.0056

QUALITY STANDARDS TO DETERMINE RELEASE OF SHELLFISH FOR MARKETING PURPOSES ...Clams, Legal Standards, Sanitation, Shelf Life & Storage, ...6.0166

BOTULINUM FOOD POISONING IN RELATION TO FISHERY PRODUCTS ...Antibiotics, Clostridium Botulinum, Fish -non-specific, Great Lakes-general, Repression, ...6.0087

MICROFLORA OF RADIATION PASTEURIZED SEAFOODS ...Organoleptic Studies, Radiation, Radiation Sensitivity-, Refrigeration, Shellfish -non-specific, ...6.0171

VITAMIN K5 AS A FOOD PRESERVATIVE ...Food Bacteria, Food Processing -other, Repression, Vitamin K, ...6.0075

INVESTIGATE THE EFFECT OF IRRADIATION ON THE MICROBIAL FLORA SURVIVING IRRADIATION PASTEURIZATION OF SEAFOODS ...Consumer Pref. & Consumption, Food Spoilage Detection, Radiation, Radiation Protectors, Shellfish -non-specific, ...6.0072

THE STORAGE LIFE OF ICED DEEP SEA RED CRABS - GERYON QUINQUEDENS ...Crabs, Iced Cooling and Storage, Organoleptic Studies, Shelf Life & Storage, ...6.0077

DISTRIBUTION OF C. BOTULINUM IN COMMERCIAL SMOKED FISH ...Bacterial Pollutant Sources, Clostridium Botulinum, Fish -non-specific, Food (epidemiology), Smoking, ...5.0337

CHEMICAL AND MICROBIOLOGICAL APPLICATIONS TO PRODUCT ENGINEERING ...Design, Machinery, Equipment, Freezing, Iced Cooling and Storage, Oysters, Shrimp, ...6.0050

LABORATORY SCALE INVESTIGATION INTO THE FEASIBILITY OF RADIOPASTEURIZING FISH PRODUCTS ...Chemical Analysis, Organoleptic Studies, Radiation, Shelf Life & Storage, Shellfish -non-specific, ...6.0035

INCIDENCE OF BACTERIA OF PUBLIC HEALTH SIGNIFICANCE IN FRESH COMMERCIAL SHELLFISH ...Coliforms (non-specific), Crabs, Oysters, Radiation, Salmonella (non-specific & Ot), Staphylococcus (non-spec.& Ot), ...6.0038

SHIPBOARD IRRADIATION STUDIES ...Fish -non-specific, Food Raw Quality, Medical Studies, Radiation, Shelf Life & Storage, ...6.0039

GROWTH AND TOXICOGENESIS OF C. BOTULINUM IN FISHERY PRODUCTS ...Antimetabolites -non-specific, Bacterial Exotoxins, Clostridium Botulinum, Fish -non-specific, Growth (non-specific & Ot.), Medical Studies, ...6.0043

EFFECTS OF HANDLING AND PROCESSING PROCEDURES IN POTENTIAL PATHOGENUS ON FISH ...Clostridium Botulinum, Fish -other, Legal Standards, Smoking, Toxicological and Allergy, ...6.0044

BACTERIOLOGICAL SURVEYS FOR MICROBIAL STANDARDS FOR FOOD ...Crabs, Escherichia Coli, Food Spoilage Detection, Legal Standards, Staphylococcus (non-spec.& Ot), ...6.0010

THERMAL DESTRUCTION OF TYPE E CLOSTRIDIUM BOTULINUM ...Clostridium Botulinum, Differentiation Mechanism, Food (epidemiology), Heat Resistance, Spore Studies, ...6.0006

ECOLOGY OF CLOSTRIDIUM BOTULINUM TYPE E IN GREEN BAY ...Fish -non-specific, Great Lakes-general, ...5.0850

PROGRAM PROJECT - FOOD MICROBIOLOGY ...Clostridia (non-specific & Ot), Food (epidemiology), Infection, Intoxication & Pois, Salmonella (non-specific & Ot), Toxicological and Allergy, ...6.0005

ANAEROBIC BACTERIA IN THE MARINE ENVIRONMENT ...Fish -non-specific, Food (epidemiology), Isolation From Nat. environ. , ...5.0846

STUDIES ON VIBRIO FOOD POISONING ...Bacteria, Bacterial Endotoxins, Food (epidemiology), Toxicological and Allergy, Vasomotor, ...6.0114

LOW TEMPERATURE GROWTH OF BACTERIA ON FOODS ...Cryophilic Bacteria, Fish -non-specific, Growth (non-specific & Ot.), Isoenzymes, Refrigeration, Temperature, ...6.0086

ORGANISMS RESPONSIBLE FOR TOXICITY OF ALASKAN CLAMS ...Alaska, Biological Pollutants -general, Clams, Food Spoilage Detection, Pollutants-general, ...5.0344

Physical Decomposition

INVESTIGATION OF DECOMPOSITION IN SHRIMP ...Ammonium, Food Spoilage Detection, Shrimp, ...6.0011

INVESTIGATION OF THE PRESERVATION OF FOODS BY FREEZE DRYING ...Beef, Food Spoilage Detection, Freeze Drying, Legal Standards, Shrimp, ...6.0012

Radioactive Isotopes

EFFECTS OF INGESTION OF RADIOACTIVE FISH AND THE NATURE AND BIOLOGY OF TOXINS IN CERTAIN FISHES ...Fish -non-specific, Food (epidemiology), Food Chains, Toxicological and Allergy, ...6.0108

RADIOCHEMICAL TECHNIQUES ...Food Spoilage Detection, Mercury, Polonium, Smoking, Wheat, ...**6.0008**

Rancidity

ANTIOXIDANT AND NUTRITIONAL POTENTIAL OF FERMENTED AND UNFERMENTED SOYBEANS IN COMBINATION WITH FISH ...Fermentation, Malting, Fish -non-specific, Food Spoilage Detection, Proteins, Soybeans, ...**6.0023**

LIPID OXIDATION AND ASSOCIATED BIOCHEMICAL CHANGES OCCURRING DURING THE PROCESSING AND STORAGE OF FISHERY PRODUCTS ...Anti-oxidants, Chemical Analysis, Fats, Fish -non-specific, Food Spoilage Detection, ...**6.0071**

COMPOSITION STUDIES OF FISH AND SHELLFISH AS RELATED TO STORAGE AND PROCESSING PROBLEMS ...Crabs, Fish -other, Freezing, Mackerel, Packaging, ...**6.0046**

CONTROL OF OXIDATIVE CHANGES IN FRESHWATER FISH ...Chemical Analysis, Fish -non-specific, Freezing, Fresh Water, Organoleptic Studies, ...**6.0045**

Supplements

UTILIZATION OF HAKE, DOGFISH, AND BY-PRODUCTS OF THE FILLET INDUSTRY FOR PROTEIN SUPPLEMENTS ...Anti-oxidants, Chemical and Spices, Fish -other, Fish Protein Concentrate, Heat, Nutritive Value, ...**6.0067**

Transportation and Marketing

Food Transport -other

PRESERVATION AND DEVELOPMENT OF FOOD PRODUCTS ...Fish & Shellfish, Fish -non-specific, Food Raw Quality, Packaging, Processed Product Quality, ...**6.0084**

Forecasting-prediction

PREDICTION OF EXTREME ENVIRONMENTAL FACTORS ...Meteorological Extremes, Statistics-general, Technique Development, Waves, Wind-general, ...**4.0048**

STUDY OF RELATIONSHIP BETWEEN EARTHQUAKES AND TECTONIC MOVEMENTS IN ALASKAN FAULT ZONE ...Alaska, Crustal Fracturing, Deformation, Earthquakes, Fault Complexes, ...**7.0139**

HIGH FREQUENCY OCEAN WAVES ...Aircraft, Photogrammetry, Radar, Waves, Wind-water Interaction, ...**2.0121**

HIGH FREQUENCY WAVES ...Heat and Radiation Transfer, Hydrodynamics, Water Motion Recorders, Waves, ...**2.0113**

TSUNAMI RUNUP EXPERIMENTS ON A SCALE MODEL OF OAHU ...Hawaii, Model Studies, Tsunami, ...**2.0111**

WAVE, CURRENT AND STORM SURGE RESPONSE TO EXTREME WIND CONDITIONS ...Currents-ocean, Model Studies, Storms-general, Waves, Wind-water Interaction, ...**2.0107**

DETERMINATION OF TIDES IN THE REAL OCEANS ...Numerical Analysis-other, Partial, Tides, ...**2.0089**

THEORETICAL STUDIES OF TSUNAMI PROPAGATION ...Depth, Environmental Effects-geologic, Geomorphology-topography, Tsunami, Waves, ...**2.0122**

AIR-SEA INTERACTION ...Heat and Radiation Transfer, Meteorological Studies, Thermal, Wind-water Interaction, ...**3.0023**

CHARACTERISTICS, CAUSES, AND PREDICTION OF UPWELLING WATER MASSESS OFF OREGON ...Mixing, Oceanic Fronts, Oregon, Pacific Ocean-east, Water Motion Recorders, ...**2.0062**

THEORETICAL STUDY OF OCEAN TIDES FOR PURPOSES OF WORLDWIDE PREDICTION ...Earth Tides, Mediterranean Sea-other, Tides, Waves, ...**2.0090**

PROPAGATION AND REFRACTION OF OCEAN WAVES IN NEAR SHORE REGIONS ...Mathematical Analysis, Operational Aspect, Surface Environments, Waves, ...**2.0117**

AIR-SEA INTERACTION (WAVES) ...British West Indies, Heat and Radiation Transfer, Surface Environments, Waves, Wind-water Interaction, ...**3.0016**

THEORETICAL AND LABORATORY MODEL STUDIES OF LARGE-SCALE OCEAN CIRCULATION ...Circulation-general, Currents-ocean, Gulf Stream, Model Studies, Transducers, ...**2.0023**

SATELLITE COMMUNICATION TESTS ...Buoys, Marine Environments-general, Satellites, Telemetry-other, Very High Frequency, ...**4.0001**

MEASUREMENT AND INTERPRETATION OF MOTIONALLY-INDUCED ELECTRIC FIELDS IN THE SEA ...Currents-ocean, Electrical, Marine Environments-general, Model Studies, Moorings, Water Motion Recorders, ...**1.0139**

RADIANT ENERGY FLUX ACROSS THE AIR-SEA INTERFACE AND HEAT BUDGET OF THE OCEANS ...Air-sea Boundary-general, Heat and Radiation Transfer, Heat Exchange, Radiation-general, Thermal, ...**3.0032**

MODEL STUDIES OF REFRACTION OF SHOALING OCEAN WAVES ...Model Apparatus-other, Model Studies, Shoals, Wave, Waves, ...**8.0194**

NUMERICAL OCEANOGRAPHIC MODEL DEVELOPMENT FOR ENVIRONMENTAL PREDICTION ...Marine Environments-general, Meteorological Studies, Model Studies, Oceanic Fronts, Weather Forecasting, ...**4.0077**

SEA ICE MOVEMENT DYNAMICS ...Charts, Mapping, Model Studies, Polar, Sea Ice, ...**3.0087**

TURBULENCE OVER WAVES ...Heat and Radiation Transfer, Heat Exchange, Meteorological Studies, Thermal, Turbulence, Waves, ...**3.0027**

SPECTRAL ANALYSIS ...Data Reduction and Analysis, Handbooks, Oceanography-general, Spectral Analysis, ...**11.0032**

OCEANOGRAPHIC RESEARCH ...Acoustical, Submersibles, Temperature, ...**1.0161**

OCEAN CIRCULATION ...California Current, Circulation-general, Hydrodynamics, Model Studies, Submarine Canyons, ...**2.0002**

EARTHQUAKE HAZARD - A PUBLIC POLICY PROBLEM IN THE SAN FRANCISCO BAY AREA ...California, Earthquakes, Faults, Intergovernmental Relations, Policy Making, San Francisco Bay, ...**9.0002**

FLUID MECHANICS RESEARCH ...Hydrodynamics, Industrial Engineering, Ship Resistance Stability, Waves, ...**8.0176**

OCEANOGRAPHIC RESEARCH - INVESTIGATIONS WITH THERMISTOR CHAIN ...Acoustical, Temperature, Thermal, Transmission, Water Properties-general, Waves-internal, ...**1.0143**

OCEANOMETRICS ...Acoustical, Statistics-general, Transmission, Velocity, ...**1.0006**

SHALLOW WATER OCEANOGRAPHY ...Continental Shelf, Environmental Effects-geologic, Pressure, Subsurface Environments, Waves, ...**1.0172**

NUMERICAL WAVE PREDICTION ...Development of Models, Model Studies, Numerical Analysis-other, Waves, ...**2.0104**

ADVANCED TECHNOLOGY AND BOTTOM PREDICTIONS ...Acoustical, Benthonic-bottom, Data Acquisition, Data Analysis - General, Model Studies, Seismic Studies, ...**1.0045**

PREDICTION OF POLAR ICE BEHAVIOR AND DISTRIBUTION ...Arctic Ocean, Data Acquisition, Hydrodynamics, Ice-general, Sea Ice, Weather Forecasting, ...**3.0078**

PREDICTIVE OCEAN ACOUSTICS ...Acoustical, Velocity, ...**1.0033**

PREDICTIVE OCEAN ACOUSTICS ...Acoustical, Environmental Effects-geologic, Transmission, Velocity, ...**1.0034**

UNDERWATER ACOUSTIC ANALYSIS ...Acoustical, Phase Relationships, Signal Analysis-other, Transmission, Water Properties-general, ...**1.0038**

MEASUREMENT OF UNDERWATER ACOUSTIC PROPAGATION ...Acoustical, Depth, Intensity, Transmission, ...**1.0014**

GREAT LAKES RESEARCH - MONITORING OF WATER CHARACTERISTICS ...Data Acquisition, Geophysical Analysis, Great Lakes-general, Instrumentation-general, Temperature, ...**1.0185**

SPACE APPLICATIONS TO FISHERIES OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM) ...Commercial Fishing, Computer Applications, Satellites, Water Environment - other, ...**4.0172**

Forestry

EFFECTS OF LOG RAFTING ON DUNGENESS CRAB ...Contamination - Water, Crabs, Diving and Scuba, Mans Activities, Pulp, Paper , and Logging, ...**5.0347**

MOBILITY OF OIL-TYPE PRESERVATIVES IN IMMERSED WOOD ...Creosote, Evaluation, Liquid - Solid Interactions, Marine Biology (non-specific), Wood Preservatives-non-specif, ...**8.0238**

Fouling

ANTI-FOULING MEANS FOR MARINE PROPELLERS ...Corrosion Prevention-other, Marine Propulsion, Materials Used Undersea, ...**8.0240**

NEW APPROACHES TO BIOFOULING ASSAY ...Bioassays, Corrosion Prevention-other, Marine Biology (non-specific), Paint - General, Powder, ...**5.0757**

CORROSION RESEARCH ...Cathodic Protection, Corrosion General, Galvanic, Water, ...**8.0199**

ANTIFOULING RESEARCH ...Corrosion Prevention-other, Materials Used Undersea, Water, ...**8.0200**

MICROBIAL CORROSION AND DETERIORATION OF NAVAL MATERIALS ...Biological, Classification Or Taxonomy, Ionic Effect, Marine Bacteria, Materials Used Undersea, ...**8.0203**

PILING PRESERVATIVES THRESHOLD STUDIES ...Biological, Massachusetts, North Carolina, Preservatives, Wood, ...**8.0232**

PHYLOGENETIC RELATIONS OF FOSSIL AND LIVING GYMNOLAEMATES ...Bryozoa, Geologic, Other Bryozoa, Phylogenies, ...**5.0665**

BENTHIC COMMUNITIES ...Behavioral Ecology, Benthic Fauna, Bottom Sampling Device, Developmental Physiology, Metabolism, Productivity - Food Chain, ...**5.0561**

BEHAVIOR AND SPECIFICITY IN MARINE SYMBIOSIS ...Behavioral Ecology, Environmental Ecology, Symbiosis, ...**5.0951**

ECOLOGICAL SUCCESSION ON SURTSEY ...Iceland, Plant Succession, Succession, Volcanoes, ...**5.0890**

ECOLOGY OF MARINE BIVALVE MOLLUSCAN LARVAE ...Behavioral Ecology, Clams, Population Dynamics, Productivity - Food Chain, Vertical Distribution, ...**5.0370**

BENTHONIC BIOLOGY ...Benthic Organisms (non-specif), Environmental Ecology, Marine Biology (non-specific), Number Or Density, Temporal Distribution, ...**5.0900**

STUDIES ON MOLTING, GROWTH, AND DEVELOPMENT IN ACORN BARNACLES AND LARVAL DECAPODS ...Barnacles, Biological Rhythms, Developmental Physiology, Endocrine System, ...**5.0296**

MARINE-BACTERIA CULTURE ...Bacterial Culture, Biological, Isolation From Nat. environ. , Marine Bacteria, Water Bacteria, ...**5.0849**

THE ROLE OF SULFUR BACTERIA IN CORROSION AND DETERIORATION ...Autotrophic, Biological, Marine Bacteria, Plasma Membrane, Sulfur Bacteria, ...**5.0805**

MICROBIAL CORROSION IN THE MARINE ENVIRONMENT ...Biodegradation, Biological, Carbon, Marine Fungi (non-specific), Water, ...**5.0769**

MICROBIOLOGICAL CONTROL IN NAVY AND MARINE CORPS OPERATING ENVIRONMENTS ...Medical Studies, Microorganisms (non-specific), Oxygen, ...**5.0740**

MECHANISMS OF CALCIUM CARBONATE DEPOSITION ...Barnacles, Biogeochemical Process, Calcium, Chemical Reactions, Derivatives, ...**5.1015**

MARINE FUNGI DEGRADATION ...Cellulose, Growth and Differentiation, Marine Fungi (non-specific), Nutrition Studies, ...**8.0225**

MICROBES AND CORROSION ...Cathodic Protection, Extracellular-enzymes, Iron, Metals -non-specific, Microorganisms (non-specific), Respiration, ...**8.0228**

OCEANOGRAPHIC RESEARCH ...Abyssal, Benthonic-bottom, Geomorphology-topography, Marine Soils, Tables, Compilations, Catalogs, ...**8.0343**

DEGRADATION OF MARINE SURFACES BY SALT REQUIRING BACTERIA ...Control and Regulation, Dna-satellite, Halophilic Bacteria, Isolation From Nat. environ. , Metabolic-biochemical Genetics, ...**5.0818**

MECHANISMS OF ATTACHMENT OF MARINE BACTERIA TO SURFACES ...Adsorption & Interface, Biological, Corrosion Prevention-other, Marine Bacteria, ...**5.0810**

FOULING OF SENSORS ...Inhibitors, Instrumentation-general, Marine Biology, Organometallics, ...**8.0239**

DEEP-WATER FOULING ...Biological, Fish -non-specific, Predation, Vertical Distribution, ...**8.0233**

BIOLOGICAL EVALUATION OF EACH EXISTING SEED OYSTER BED IN DELAWARE BAY ...Delaware Bay, Number Or Density, Oysters, Spawning & Nesting Sites, ...**5.0382**

STEEL PILING ...Corrosion Prevention-other, Low Alloy Steels, Polarization, Soils, Water, ...**8.0208**

MICROBIAL CORROSION ...Alloys, Biological, Marine Bacteria, Sulfur Bacteria, Water, ...**8.0207**

CHEMICAL WOOD PRESERVATIVE TREATMENTS ...Biological, Corrosion Prevention-other, Creosote, Wood Preservatives-non-specif, ...**8.0197**

DRAG-REDUCING ALGAE ...Algae- General, Coatings-general, Marine Bacteria, Natural Occurring, Secretions and Products, Wear, Friction, ...**5.0681**

EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE ...Creosote, Isopods, Petroleum Cpds. -non-specific, Preservatives, Wax, Paraffin, Wood Preservatives-non-specif, ...**8.0198**

BIOCHEMISTRY OF MARINE ORGANISMS ...Adsorption & Interface, Bioluminescence, Phytoplankton, Plant Succession, Spectroscopy, ...**5.0766**

PRESERVATION OF WOODS IN THE MARINE ENVIRONMENT ...Biological, Habitat Studies, Marine Fungi (non-specific), Materials Used Undersea, Preservatives, Wood, ...**8.0216**

SUPPORTING TECHNOLOGY AT NAVAL RESEARCH LABORATORY ...Abyssal, Microorganisms (non-specific), Organics, Submersibles, ...**8.0217**

CORROSION MITIGATION ...Corrosion Prevention-other, Deep, Low Alloy Steels, Pre-stressed, Water, ...**8.0205**

Foundations

Deep

SEA BED INSTALLATION ...Benthonic-bottom, Diving and Scuba, Stabilization, Submersibles, Underwater-construction, ...**8.0331**

CORROSION MITIGATION ...Corrosion Prevention-other, Fouling, Low Alloy Steels, Pre-stressed, Water, ...**8.0205**

Foundations-general

CIVIL ENGINEERING STRUCTURES IN THE OCEANS ...Coastal Engineering-other, Engineering Studies-other, Model Studies, Soil Dynamics, Waves, ...**8.0340**

BOTTOM SOIL PROPERTIES AND FOUNDATIONS ...Bearing Capacity, Consolidation, Mechanical Properties, Shear Strength, Soil Testing-general, ...**8.0332**

Freezing Techniques

CRYOGENIC PRESERVATION OF VIABLE FISH SPERM ...Artifical Insemination, Cellular Physiology, Fish -non-specific, Male Gametes, ...**5.0303**

CRYOGENIC PRESERVATION OF VIABLE FISH SPERM ...Fertility, Fish -non-specific, Male Gametes, Rapid Freeze, ...**5.0310**

Freeze-dry Techniques

FREEZING AND DRYING OF LIVING CELLS ...Animal Nematodes -non-specific, Cell Injury and Autolysis, Cell. env.(non-specific & Ot.), Mollusks -non-specific & Other, Tissue Techniques, ...**5.0450**

Lyophilization

COLLECTION AND EXTRACTION OF MARINE INVERTEBRATES AND PLANTS ...Collections, Extracts, Marine Plants, ...**5.0697**

Rapid Freeze

CRYOGENIC PRESERVATION OF VIABLE FISH SPERM ...Fertility, Fish -non-specific, Freezing Techniques, Male Gametes, ...**5.0310**

Frequencies

Audio Frequency

ELECTRICAL PROPERTIES OF ICE ...Electrical, Phase Relationships, Sea Ice, ...**3.0072**

BASIC ACOUSTICAL STANDARDS AND MICROPHONE CALIBRATION ...Acoustic, Acoustical, Calibration and Calibrators, Standards, Specifications, Transducers, ...**8.0076**

Frequencies-other

FREQUENCY TIME RESEARCH ENGINEERING ...Amplifiers, Electromagnetic Transmission, Frequency Conversion, Time Measurements, Very Low Frequency, ...**8.0068**

Frequency Conversion

FREQUENCY TIME RESEARCH ENGINEERING ...Amplifiers, Electromagnetic Transmission, Frequencies-other, Time Measurements, Very Low Frequency, ...**8.0068**

Frequency Standards

WWVB-WWVL BROADCASTS ...Low Frequency, Navigation, Radio, Signal Generators, Standards, Specifications, Time Measurements, Very Low Frequency, ...4.0090

Radio Frequencies

Low Frequency

WWVB-WWVL BROADCASTS ...Frequency Standards, Navigation, Radio, Signal Generators, Standards, Specifications, Time Measurements, Very Low Frequency, ...4.0090

Very High Frequency

VHF SATELLITE COMMUNICATIONS ...Navigation, Range and Tracking-other, Space Crafts, ...4.0105

SATELLITE COMMUNICATION TESTS ...Buoys, Forecasting-prediction, Marine Environments-general, Satellites, Telemetry-other, ...4.0001

Very Low Frequency

FREQUENCY TIME RESEARCH ENGINEERING ...Amplifiers, Electromagnetic Transmission, Frequencies-other, Frequency Conversion, Time Measurements, ...8.0068

WWVB-WWVL BROADCASTS ...Frequency Standards, Low Frequency, Navigation, Radio, Signal Generators, Standards, Specifications, Time Measurements, ...4.0090

VLF TIMING STUDIES ...Attenuation, Absorption, Electromagnetic Transmission, Navigation, Standards, Specifications, Time Measurements, ...4.0092

Fresh Water

STUDIES OF FISH ENDOCRINOLOGY ...Environmental Physiology, Hormone, Killifishs - Cyprinodon, Testes, Thyroid, ...5.0246

FISH COLLECTION OF NORTH CAROLINA AND WESTERN ATLANTIC FISHES ...Atlantic Ocean-north, Collections, Fish - non-specific, North Carolina, ...5.0133

OREGON FISHES - THEIR CLASSIFICATIONS, DISTRIBUTIONS AND LIFE HISTORIES ...Animal Taxonomy, Life History Studies, Oregon, Vertical Distribution, ...5.0137

OREGON FISHES - THEIR CLASSIFICATION, DISTRIBUTION AND BIOLOGY ...Animal Taxonomy, Fish -non-specific, Oregon, Vertical Distribution, ...5.0138

FLOW AND SALINITY IN THE HUDSON ESTUARY, NEW YORK ...Estuaries, Inflow, Management, Salinity, Tides, ...2.0075

REMOTE SENSING, GULF COASTAL AREA, CENTRAL FLORIDA ...Aircraft, Aquifers, Saline Water Systems, Temperature, Tides, ...4.0160

MARINE BIOLOGICAL INVESTIGATIONS - TAXONOMIC COLLECTION OF THE FRESH AND SALTWATER FISHES OF ALASKA ...Alaska, Animal Taxonomy, Collections, Fish - non-specific, ...5.0008

CONTROL OF OXIDATIVE CHANGES IN FRESHWATER FISH ...Chemical Analysis, Fish -non-specific, Freezing, Organoleptic Studies, Rancidity, ...6.0045

Fuels

COMBUSTION OF RESIDUAL FUEL WITH MASSIVE RECIRCULATION ...Alloys, Atmospheric, Gases, Combustion Products, ...8.0226

A PILOT PLANT STUDY OF LOW EXCESS AIR COMBUSTION - ITS EFFECT ON FIRESIDE PROBLEMS IN OIL FIRED BOILERS ...Boilers, Combustion Products, Combustion-other, Maintenance-system, ...8.0168

Fungal Physiology

Growth and Differentiation

MARINE FUNGI DEGRADATION ...Cellulose, Fouling, Marine Fungi (non-specific), Nutrition Studies, ...8.0225

Metabolism

Nutrition Studies

MARINE FUNGI DEGRADATION ...Cellulose, Fouling, Growth and Differentiation, Marine Fungi (non-specific), ...8.0225

Pathological Physiology

BIOLOGICAL ACTIVITIES OF MARINE FUNGI ...Endoparasites -other, Host-parasite Interactions, Invertebrate Pathology, Marine Fungi (non-specific), Oysters, Plant Developmental Biology, ...5.0699

Fungi

Aquatic Fungi (non-specific)

SYSTEMATICS, MORPHOLOGY, AND ECOLOGICAL DISTRIBUTION OF ALGO AND WOOD-INHABITING MARINE AND FRESHWATER FUNGI OF SURTSEY AND ICELAND ...Iceland, Islands, Marine Fungi (non-specific), Plant Taxonomy, Range Or Territorial Distr. , ...5.0714

LACUSTRINE AND ESTUARINE FUNGI ...Host-parasite Interactions, Marine Fungi (non-specific), Phytoplankton, Plant Morphology, Plant Taxonomy, Range Or Territorial Distr. , ...5.0731

Dermocystidium

STUDIES ON THE DEVELOPMENT OF DERMOCYSTIDIUM MARINUM ...Cell Cycle, Control and Prevention, Fungal Culture, Oysters, Pathology, ...5.0836

Marine Fungi (non-specific)

SYSTEMATICS, MORPHOLOGY, AND ECOLOGICAL DISTRIBUTION OF ALGO AND WOOD-INHABITING MARINE AND FRESHWATER FUNGI OF SURTSEY AND ICELAND ...Aquatic Fungi (non-specific), Iceland, Islands, Plant Taxonomy, Range Or Territorial Distr. , ...5.0714

MICROBIOLOGICAL INVESTIGATIONS OF THRESHOLD PANELS ...Catabolism and Degradation, Degradation, Freshwater Mussels, Scallops, Marine Bacteria, Wood, Wood Preservatives-non-specif, ...8.0243

MORPHOLOGY AND TAXONOMY OF MARINE FUNGI ...Habitat Studies, Mangroves, Plant Morphology, Plant Taxonomy, Sub - Tropic, Tropic, ...5.0716

LACUSTRINE AND ESTUARINE FUNGI ...Aquatic Fungi (non-specific), Host-parasite Interactions, Phytoplankton, Plant Morphology, Plant Taxonomy, Range Or Territorial Distr. , ...5.0731

DISTRIBUTION OF ANTARCTIC MARINE FUNGI ...Antarctica, Phycomycetes, Plant Taxonomy, Range Or Territorial Distr. , Ships and Cruises, Vertical Distribution, ...5.0694

MICROBIAL CORROSION IN THE MARINE ENVIRONMENT ...Biodegradation, Biological, Carbon, Fouling, Water, ...5.0769

MARINE FUNGI DEGRADATION ...Cellulose, Fouling, Growth and Differentiation, Nutrition Studies, ...8.0225

EXPERIMENTAL ECOLOGY OF LOWER MARINE FUNGI ...Habitat Studies, Phycomycetes, Plant Developmental Biology, ...5.0808

PRESERVATION OF WOODS IN THE MARINE ENVIRONMENT ...Biological, Fouling, Habitat Studies, Materials Used Undersea, Preservatives, Wood, ...8.0216

COMPARATIVE BIOCHEMICAL AND MORPHOLOGICAL CHARACTERISTICS OF MARINE FUNGI FROM SHELLFISH ...Endoparasites -other, Fungal Culture, Histochemistry - Cytochem, Histology and Cytology, Plant Taxonomy, ...5.0791

WATER QUALITY AND FUNGI-NEMATODE-SEAGRASS RELATIONSHIPS ...Elodea, Waterweed, Thalassia, Florida, Habitat Studies, Nematoda -other, ...5.0878

BIOLOGICAL ACTIVITIES OF MARINE FUNGI ...Endoparasites -other, Host-parasite Interactions, Invertebrate Pathology, Oysters, Pathological Physiology, Plant Developmental Biology, ...5.0699

Mycorrhiza

SUPPORT FOR THE PHYSIOLOGICAL RESEARCH SHIP, R/V ALPHA HELIX ...Insecticides -non-specific, Nerve Effects, Rain Forests, Regulation, Tropic, ...12.0011

Myxomycetes

ULTRASTRUCTURAL STUDIES OF PARASITIC AND SAPROPHYTIC FUNGI AND PROTOZOA ASSOCIATED WITH MARINE INVERTEBRATES ...Cell Cycle, Electron Microscopy, Host-parasite Interactions, Protozoa, ...5.0839

STUDIES ON THE PROTISTAN CAUSING MALPEQUE DISEASE ...Invertebrate Pathology, Oysters, Pathology, Plant Taxonomy, Range Or Territorial Distr. , ...5.0498

Fungi

Phycomycetes

DISTRIBUTION OF ANTARCTIC MARINE FUNGI ...Antarctica, Marine Fungi (non-specific), Plant Taxonomy, Range Or Territorial Distr. , Ships and Cruises, Vertical Distribution, ...5.0694

EXPERIMENTAL ECOLOGY OF LOWER MARINE FUNGI ...Habitat Studies, Marine Fungi (non-specific), Plant Developmental Biology, ...5.0808

Yeasts (non-specific)

ISOLATION AND TAXONOMY OF YEASTS IN LAKES AND SEWAGE ...Bioindicators, Contamination, Pollution-water, Plant Taxonomy, Streams, ...5.0787

Fur-bearing Animals

Management

BOTTOM FISH, FISH WASTE, SCRAP FISH & OTHER SEA PRODUCTS FOR FUR ANIMAL DIETS ...Alewife,menhaden,shad,herring, Antioxidants, Chubs, Notropis, Fish Meals, Sea Lions, Fur Seals, ...6.0001

Gaging

MEASUREMENT OF SURGING IN KUHIO BAY, HILO HAWAII ...Harbors, Hawaii, Tsunami, Water Motion Recorders, Waves, ...2.0112

INTERCOMPARISON OF TOWING TANK AND WATER TUNNEL CALIBRATION OF CURRENT METERS ...Tanks, Turbulent Flow, Water Tunnels Tables, ...8.0074

Gas Generator

HYDROGEN-OXYGEN FUEL CELLS ...Encapsulation, Fuel Cell-other, Oxidants, Safety, Submersibles, ...8.0160

Generators

LOADING CHARACTERISTICS OF A CHARGE-CONSTRAINED SYNCHRONOUS GENERATOR ...Power Conversion Systems, ...8.0163

THERMO-ELECTRIC GENERATORS ...Buoys, Thermoelectric, ...8.0162

Genetics

Environment Effects on Genome

Mutagens

SURVIVAL MECHANISM OF IRRADIATED BACTERIA IN FOODS ...Achromobacter Sp, Antibiotics, Cell Injury and Autolysis, Fish -non-specific, Radiation, ...6.0069

SELECTIVE BREEDING OF THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA (GENETICS OF SHELLFISH PROGRAM) ...Karyotypes, Morphological Action, Oysters, Reproductive System, Selection & Breeding, ...5.0376

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MORPHOGENETIC MOVEMENTS IN FISH EMBRYOS ...Basic Embryology, Fish -non-specific, ...5.0281

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MOLECULAR ASPECTS OF CELLULAR DIFFERENTIATION AND DIVISION ...Basic Embryology, Biosynthesis, Cell Cycle, Differentiation Mechanism, Proteins, Sea Urchins & Other Echinoderm, ...5.0985

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FISH GENETICS AND ECOLOGY ...DNA Other, Estuaries, Fish -non-specific, Life History Studies, ...5.0309

HEMOGLOBIN VARIATIONS AS INDICATORS OF BLUEFISH RACES ...Animal Taxonomy, Bluefish, Hemoglobin, Polymorphism, Reproduction Studies (general), ...5.0320

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PHYSIOLOGY OF FERTILIZATION AND NUCLEO-CYTOPLASMIC INTERACTIONS IN SEA URCHIN DEVELOPMENT ...Basic Embryology, Messenger RNA , Nucleus (non-specific & Ot.), Reproductive System, Sea Urchins & Other Echinoderm, ...5.0673

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STABLE ISOTOPE FRACTIONATION IN ECHINODERM CALCITE ...Animal Taxonomy, Biogeochemical Process, Calcite, Carbon, Marine Organisms, Oxygen, Sea Feathers,sea Lily... , Sea Urchins & Other Echinoderm, ...7.0085

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STABLE ISOTOPE FRACTIONATION IN ECHINODERM CALCITE ...Animal Taxonomy, Biogeochemical Process, Calcite, Carbon, Living Organisms, Oxygen, Sea Feathers,sea Lily... , Sea Urchins & Other Echinoderm, ...7.0085

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PHASE RELATIONS OF THE HYDRATED CARBONATES OF CALCIUM AND MAGNESIUM ...Carbonate, Bicarbonate, Equilibrium - Chemical, Interfacial, Properties and Structure, Surface Chemistry, ...3.0085

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PHASE RELATIONS OF THE HYDRATED CARBONATES OF CALCIUM AND MAGNESIUM ...Carbonate, Bicarbonate, Equilibrium - Chemical, Interfacial, Phase Relationships, Properties and Structure, ...3.0085

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CARBON ISOTOPE GEOTHERMOMETRY ...Carbon, Carbonaceous Substance, Chemistry, Core Analysis, Paleotemperature, Plankton (non-specific), Temperature, ...7.0079

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HIGH PRESSURE ROCK STUDIES ...Attenuation, Crystalline, High Temperature Research, Rock Mechanics, ...8.0336

RESEARCH ON THE PHYSICAL CHEMISTRY OF CHEMICAL REACTIONS IN SEA WATER ...Acids, Apatite-general, Carbonate, Bicarbonate, Chemical Reactions, Equilibrium - Chemical, Reaction-general, Solubility, Sulfate, Sulfite, ...1.0127

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High Temperature Research

HIGH PRESSURE ROCK STUDIES ...Attenuation, Crystalline, High Pressure Research, Rock Mechanics, ...8.0336

UPPER MANTLE OF OCEAN REGIONS ...Earth Interior, Extrusives, High Pressure Research, Lava, Petrology, Ridges, ...7.0053

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DEEP OCEAN AS RECIPIENT OF VOLATILES AND SOLUTES ...Igneous Activity - Volcanism, Lithology, Pacific Ocean-east, Ridges, Sea Floor Spreading, Thermal Features, Water Analysis-general, ...7.0095

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Phase Relationships

MINERAL-WATER CHEMISTRY, GREAT LAKES ...Chemical Reactions, Great Lakes-general, Mineral Equilibra, Mineral Genesis, Model Studies, Solution Chemistry, ...**1.0117**

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SOLUTION-SILICATE REACTIONS AND [illegible]RIA ...Chemical Reactions, Chemistry, Equilib[illegible]cal, Groundwater, Reaction-general, Silicate-gene[illegible]olution, ...**1.0097**

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MINERAL-WATER CHEMISTRY, GREAT LAKES ...Chemical Reactions, Great Lakes-general, Mineral Equilibra, Mineral Genesis, Model Studies, Phase Relationships, ...**1.0117**

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Geochemical Investigations

Element Ratios

THE GEOCHEMISTRY OF RADIOACTIVE ELEMENTS IN THE MARINE ENVIRONMENT - THE GEOCHEMISTRY OF LANDLOCKED SEAS ...Distribution, Oceans - Sea Water, Radioactive Dating, Sedimentation, Uranium, ...**1.0095**

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DEPOSITION RATES BY THE PROTACTINIUM METHOD ...Chemical, Distribution, Manganese, Sedimentary Petrogenesis, Thermal, Thorium, Uranium, ...**7.0270**

AZORES VOLCANIC STUDY ...Atla[illegible] Ocean-general, Azores, Igneous Activity - Volcanism, Ridge[illegible]canic, ...**8.0195**

STABLE CARBON AND OXY[illegible]TOPE RATIO VARIATIONS IN THE FLOW T[illegible]ARBON AND OXYGEN THROUGH NORMAL AND POLLUTED AQUATIC SYSTEMS ...Carbon, Organic-general, Oxygen, Pollutants - Path of , Sewerage Systems-other, Water Analysis, ...**1.0132**

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SIGNIFICANCE OF FLUORIDE VARIATIONS IN SEA WATER ...Atlantic Ocean-general, Chloride, Extrusives, Fluoride, Water Analysis-general, ...**1.0105**

TRACE ELEMENT AND STABLE ISOTOPE STUDIES OF CORAL REEF CARBONATES ...Diagenesis, Fossil Limestone, Paleoenvironments, Reefs, Trace Element Analysis, ...**7.0086**

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STABLE ISOTOPE STUDIES ON COEXISTING MINERALS IN MARINE SEDIMENTS ...Coring and Dredging, Diagenesis, Mineralogy, Red Sea, Salinity, Thermal, ...**1.0106**

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POTASSIUM/ARGON DATING OF DEEP-SEA SAMPLES ...Abyssal, Argon-potassium, Microfossils, Radioactive Dating, Sea Floor Spreading, Tertiary Period, ...**7.0066**

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GEOCHEMISTRY OF SAN FRANCISCO BAY ...Bays, Clays, Distribution, San Francisco Bay, Trace Element Analysis, ...**1.0074**

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CHEMICAL OCEANOGRAPHY ...Biogeochemical Process, Circulation-general, Geologic, Organics, Trace Elements, ...**1.0129**

ISOTOPIC AND TRACE ELEMENT STUDIES IN OCEANIC VOLCANIC ROCKS ...Igneous Rocks, Lead, Magma, Magmas, Petrology, Strontium, Trace Element Analysis, Volcanic, ...**7.0075**

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TRACE ELEMENTS IN SEA WATER ...Activation Analysis, Isotope Tracer-other, Long Island Sound, Radioactivity-general, ...**1.0085**

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ROLE OF WIND-BORNE CONTINENTAL DUST IN OCEAN SEDIMENTATION PROCESSES ...Distribution, Dust - Particulate Matter, Location, Rate of Deposition, Terrigenous, ...**7.0230**

STRONTIUM ISOTOPE COMPOSITION AND TRACE ELEMENT CONCENTRATIONS IN LAKE HURON AND ITS PRINCIPAL TRIBUTARIES ...Chemical, Ions and Gases, Lake Huron, Rocks - Bedrock, Strontium, ...**1.0124**

DIAGENESIS OF CARBONATE SEDIMENTS ...Carbonates-general, Core Analysis, Diagenesis, Geochemistry-general, Pore Fluids, ...**7.0266**

AGE RELATIONS OF IGNEOUS ROCKS FROM THE MID-ATLANTIC RIDGE ...Extrusives, Foliated Rocks, Geologic Age Relations, Rare Earth Studies, Ridges, ...**7.0080**

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THE GEOCHEMISTRY OF RADIOACTIVE ELEMENTS IN THE MARINE ENVIRONMENT - THE GEOCHEMISTRY OF LANDLOCKED SEAS ...Distribution, Element Ratios, Radioactive Dating, Sedimentation, Uranium, ...**1.0095**

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TECTONIC AND GEOLOGICAL HISTORY OF THE SOUTHWEST PACIFIC REGION ...Gases, Geophysics-general, Island Arcs, Pacific Ocean-south, Structural Studies, Tectonics-general, ...**7.0031**

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GEOCHEMICAL STUDIES OF DEEP-SEA DEPOSITS - THEIR SOURCES AND MODES OF DEPOSITION ...Abyssal, Atlantic Ocean-general, Biogenous, Biogeochemical Process, Chemistry, Mineralogy, ...**7.0057**

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NEUTRON ACTIVATION ANALYSIS OF IRON METEORITES ...Activation Analysis, Aluminum, Argon-potassium, Carbon, Cosmogenous, Neutron Activation, ...**7.0065**

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ELECTRON MICROSCOPE AND ELECTRON DIFFRACTION STUDIES OF GEOLOGICAL SAMPLES ...Electron, Electron Microscopy, ...**7.0278**

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GEOCHEMISTRY OF NUCLEIC ACIDS ...Biochemical, Chemistry, Exobiology, Nucleic Acids -non-specific, Organic, ...**7.0054**

BIOGEOCHEMISTRY OF TERRESTRIAL & EXTRATERRESTRIAL ORGANIC MATTER ...Biochemical, Biogenous, Diagenesis, Exobiology, Organic, Sulfur Bacteria, ...**7.0074**

URANIUM GEOCHEMISTRY IN (MODERN) CARBONATES USING THE FISSION TRACK METHOD ...Carbonates-general, Chemistry, Diagenesis, Organism Sampling Devices, Uranium, ...**7.0076**

CHEMICAL OCEANOGRAPHY ...Circulation-general, Geologic, Organics, Rare Earth Studies, Trace Elements, ...**1.0129**

BIOGENESIS OF CARBONATE SEDIMENTS, BAHAMA ISLANDS ...Bioclastic Limestone, Biofacies, British West Indies, Classification - Taxonomy, Sedimentary Petrogenesis, ...**7.0241**

STABLE ISOTOPE FRACTIONATION IN ECHINODERM CALCITE ...Animal Taxonomy, Calcite, Carbon, Living Organisms, Marine Organisms, Oxygen, Sea Feathers,sea Lily... , Sea Urchins & Other Echinoderm, ...**7.0085**

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MECHANISMS OF CALCIUM CARBONATE DEPOSITION ...Barnacles, Calcium, Chemical Reactions, Derivatives, Fouling, ...**5.1015**

STUDIES IN MARINE CHEMISTRY ...Bone, Chemistry, Trace Elements, ...**7.0068**

Carbonaceous Substance

GEOCHEMICAL OCEANOGRAPHY ...Acids, Organic, Organics, ...**1.0102**

CARBON ISOTOPE GEOTHERMOMETRY ...Carbon, Chemistry, Core Analysis, Geologic Thermometry, Paleotemperature, Plankton (non-specific), Temperature, ...**7.0079**

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GEOLOGIC HISTORY OF PACIFIC FAUNAS ...Evolutionary Studies-general, Pacific Ocean-general, Paleoecology, Paleontology, Sea Level Changes, ...**7.0156**

GEOCHEMISTRY OF MID-ATLANTIC RIDGE SEDIMENTS ...Atlantic Ocean-general, Chemistry, Core Analysis, Correlation, Ridges, ...**7.0071**

CORING OF THE VARVED SEDIMENTS IN SAANICH INLET ...Canada, Coring and Dredging, Local Stratigraphy, Pacific Ocean-east, Varves, ...**7.0282**

CORRELATION OF SUBMARINE VOLCANIC ASH BY CATHODO-LUMINESCENCE ...Correlation, Extrusives, Luminescence, Qualitative, Size, ...**7.0255**

UNIVERSITY OF SOUTHERN CALIFORNIA CONTRACT - CHANNEL ISLANDS AND BASINS SOUTHERN CALIFORNIA CONTINENTAL MARGIN ...California, Continental Shelf, Continents, General Mineralogic Properties, Mineralogy, ...**7.0223**

Radioactivity Methods

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NEUTRON ACTIVATION ANALYSIS OF IRON METEORITES ...Activation Analysis, Aluminum, Carbon, Cosmogenous, Iron, Neutron Activation, ...**7.0065**

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POTASSIUM/ARGON DATING OF DEEP-SEA SAMPLES ...Abyssal, Geologic Age Relations, Microfossils, Radioactive Dating, Sea Floor Spreading, Tertiary Period, ...**7.0066**

PETROLOGY AND GEOCHEMISTRY OF IGNEOUS ROCKS FROM THE OCEAN FLOOR ...Extrusives, Pacific Ocean-east, Petrography, Petrology, Ridges, Sima, ...**7.0064**

Carbon-14

CHEMICAL OCEANOGRAPHY ...Carbon, Chemical Reactions, Gulf of Mexico, Organics, Reaction-general, ...**1.0131**

CARBON-14 AGE PROFILE OF A HAWAIIAN REEF ...Anthozoa, Coring and Dredging, Growth Rate, Hawaii, Reefs, Sea Level Variations, ...**7.0051**

INVESTIGATION OF QUATERNARY SEA LEVEL CHANGES IN THE CAROLINE AND MARSHALL ISLANDS ...Emergent, Pacific Ocean-south, Quaternary Period, Reefs, Sea Level Variations, ...**7.0159**

RADIOCARBON DATING OF A HAWAIIAN REEF PROFILE ...Hawaii, Radioactive Dating, Reefs, Sea Level Variations, ...**7.0087**

AN INVESTIGATION OF THE MASS PHYSICAL PROPERTIES OF CARBONATE MUD SEDIMENTS ...Carbonates-other, Core Analysis, Density, Physical Properties, Porosity, ...**7.0225**

NATURAL RADIOCARBON MEASUREMENTS ...Facilities, Mixing, Oceanic Fronts, Pacific Ocean-general, Radioactivity, ...**1.0084**

PROPERTIES AND ORIGIN OF SEDIMENTS IN THE NORTHEAST PACIFIC OCEAN ...Core Analysis, Origin, Pacific Ocean-east, Physical Properties, Washington, ...**7.0287**

RELICT COPEPODS FROM LAKE TUBORG, ELLESMERE ISLAND ...Brackish Water, Canada, Copepods, Lakes, Plankton Sampling, ...**5.0388**

Uranium

INVESTIGATIONS OF URANIUM AND THORIUM SERIES ISOTOPE DISEQUILIBRIUM IN THE OCEAN AND IN PLEISTOCENE SEDIMENTS ...Chemistry, Glacial History, Quaternary Period, Radioactivity, Radium, Thorium, ...**1.0120**

THE GEOCHEMISTRY OF RADIOACTIVE ELEMENTS IN THE MARINE ENVIRONMENT - THE GEOCHEMISTRY OF LANDLOCKED SEAS ...Distribution, Element Ratios, Oceans - Sea Water, Radioactive Dating, Sedimentation, ...**1.0095**

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Geodetic Surveys

GRAVITY SURVEY ARCTIC OCEAN ...Bathymetry, Beaufort Sea, Continental Shelf, Gravity Studies, Seismic Studies, Structural Studies, ...**7.0154**

Standard Geoid

MARINE PHYSICAL GEODESY ...Aerospatial, Caribbean Sea, Gravity Studies, Navigation, Sea Level Variations, ...**4.0058**

Geodetic Instrumentation

Gravimetric

NEW SEA GRAVITY METER ...Capacitance, Geophysical Equipment, Gravity Studies, Instrumental Services, Transducers, ...**8.0067**

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MARINE GRAVITY ...Gravity Studies, Gravity Surveys, Navigation, Variations, ...**4.0107**

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PHYSICAL GEOGRAPHY OF TROPICAL COASTAL LOWLANDS ...Development, Physical, Physical Features-general, Shore Features-general, Tropic, ...**7.0298**

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UNIVERSITY OF SOUTHERN CALIFORNIA CONTRACT - CHANNEL ISLANDS AND BASINS SOUTHERN CALIFORNIA CONTINENTAL MARGIN ...California, Continental Shelf, General Mineralogic Properties, Geochronology-general, Mineralogy, ...**7.0223**

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EVALUATION OF CONTEMPORARY ACOUSTIC, MAGNETIC AND GRAVIMETRIC METHODS FOR DETERMINING SIZE AND SHAPE OF DEPOSITS ...Geophysical Equipment, Instrumental Services, Magnetic Studies, Sonar, Survey Studies, ...7.0007

Heat Flow Measurements

MARINE GEOPHYSICS ...Caribbean Sea, Geomorphology-topography, Geophysical Equipment, Magnetic Studies, Structural Studies, ...7.0115

GEOTHERMAL MEASUREMENTS ...Geomorphology-topography, Geothermal Gradient, Physical Analysis, Physical Properties, Temperature, ...7.0136

HEAT FLOW AND MAGNETICS IN THE PHILIPPINE SEA ...Arcs, Magnetic Studies, Philippine Sea, Sea Floor Spreading, Trenches, ...7.0137

COLLECTION AND INTERPRETATION OF OCEANIC THERMAL GRADIENTS ...Bathythermographs, Gulf of Mexico, Pacific Ocean-east, Temperature, ...1.0187

DETAILED STUDY OF THE OCEANIC CRUST BY MEANS OF DEEP SEISMIC PROFILING ...Continental Shelves, Seismic Studies, Subbottom, Textures-structures, Washington, ...7.0152

TEMPERATURE MICROSTRUCTURE AT THE OCEAN FLOOR ...Instrumental Services, Oregon, Physical Properties, Technique Development, Temperature, ...1.0188

A STUDY OF THE TEMPERATURE MICROSTRUCTURE AND EDDY TRANSPORT IN THE OCEAN FLOOR BOUNDARY LAYER ...Benthonic-bottom, Geothermal, Physical Analysis, Temperature, Thermodynamics, ...1.0189

ATLANTIC OCEAN CRUSTAL STUDIES ...Atlantic Ocean-general, Bathymetry, Coring and Dredging, Crust, Seismic Reflection, ...7.0116

GEOPHYSICAL INVESTIGATIONS IN THE TAIWAN-PHILIPPINE-NEW GUINEA REGION ...Basins, Gravity Surveys, Magnetic Surveys, Seismic Refraction, Seismic Surveys, ...7.0129

GEOTHERMAL INVESTIGATIONS IN OCEAN REGIONS ...Atlantic Ocean-general, Geothermal, Model Studies, Regional Structure, Technique Development, ...7.0121

THE GEOCHEMISTRY, MINERALOGY AND ORIGIN OF PELAGIC SEDIMENTS IN AREAS OF HIGH HEAT FLOW AND FRACTURE ZONES ...Chemistry, Diagenesis, Geochemistry, Mineralogy, Origin, Sedimentation, ...7.0227

HEAT FLOW MEASUREMENTS ...Atlantic Ocean-general, Geophysical Equipment, Photography, Technique Development, Water Motion Recorders, ...7.0138

HEAT FLOW MEASUREMENTS ...Basins, Melanesia, Philippines, Ridges, Temperature, ...7.0100

GEOTHERMAL STUDIES IN DEEP-SEA DRILL HOLES ...Abyssal, Bathyal, Borehole Geophysics, Core Temperature, Earth Interior, Geothermal, Heat Flows, Sediments-general, Technique Development, ...7.0122

GEOTHERMAL INVESTIGATIONS IN OCEAN REGIONS ...Atlantic Ocean-general, Oceanic - Pelagic, Ridges, Sediments-other, Temperature, ...7.0123

Magnetic Studies

PARTIAL SUPPORT OF A PROGRAM OF EDUCATION & RESEARCH IN MARINE SEISMOLOGY AND GEOMAGNETICS ...Seismic Studies, Training Grants, Fellowships, ...7.0127

RESEARCH IN MARINE GEOLOGY ...Bathymetry, Data Analysis - General, Gravity Studies, Seismic Studies, Ships and Cruises, ...4.0027

SEARCH FOR FERROMAGNETICALLY TRAPPED MAGNETIC MONOPOLES OF COSMIC RAY ORIGIN ...Field Reversals, Magnetic Monopole, Paleomagnetism, Physical Properties, ...7.0114

MARINE GEOLOGY ...Acoustical, Bathymetry, Geomorphology-topography, Mapping, Sea Floor Spreading, ...7.0041

EARTH CURRENT STUDIES ...Aurora, Earth-telluric Current, ...4.0085

ARCTIC RESEARCH ...Acoustical, Arctic Ocean, Currents-ocean, Geomorphology-topography, Sea Ice, ...4.0049

MARINE GEOPHYSICS ...Caribbean Sea, Geomorphology-topography, Geophysical Equipment, Heat Flow Measurements, Structural Studies, ...7.0115

MARINE SEDIMENTS ...Atlantic Ocean-south, Bathymetry, Ridges, Sea Floor Spreading, Textures-structures, ...7.0203

HEAT FLOW AND MAGNETICS IN THE PHILIPPINE SEA ...Arcs, Heat Flow Measurements, Philippine Sea, Sea Floor Spreading, Trenches, ...7.0137

ACQUISITION, REDUCTION AND INTERPRETATION OF MARINE MAGNETIC DATA ...Anomalies, Data Acquisition, Data Reduction and Analysis, Ridges, ...4.0032

GRAVITY AND MAGNETIC DATA COLLECTED DURING THE INTERNATIONAL INDIAN OCEAN EXPEDITION AND IN THE CARIBBEAN SEA ...Data Analysis - General, Data Reduction and Analysis, Digital Computer Applications, Gravity Studies, Indian Ocean-general, Research - Development, ...4.0030

GEOLOGICAL AND GEOPHYSICAL INVESTIGATION OF THE BAHAMA BANK ...Banks, Bathymetry, British West Indies, Crust, Seismic Studies, ...7.0110

GEOPHYSICAL AND GEOLOGICAL STUDY OF THE DARWIN RISE ...Bathymetry, Coring and Dredging, Geophysics-general, Gravity Studies, Ocean Basins, Pacific Ocean-west, Photography, Refraction, Ridges, Seamounts-guyots, ...7.0112

MARINE GEOPHYSICAL STUDIES IN THE PACIFIC OCEAN ...Crust, Gravity Studies, Ocean Basins, Seismic Studies, Solomon Islands, ...7.0113

THE MAGNETIZATION OF SUBMARINE BASALTS AND ITS EFFECT ON MARINE MAGNETIC ANOMALIES ...Anomalies, Extrusives, Field Reversals, Paleomagnetism, Seamounts-guyots, ...7.0153

SEA FLOOR ROUGHNESS ...Acoustical, Attenuation, Benthonic-bottom, Bottom Sampling Device, Propagation, Transmission, ...7.0033

WOODS HOLE SHIPBOARD DATA PROCESSING ...Data Reduction and Analysis, Digital Computer Applications, Gravity Studies, Navigation, Real Time Systems, ...4.0031

SEAMOUNT INVESTIGATION ...Anomalies, Data Analysis - General, Geothermal, Ocean Mining, Seamounts-guyots, Sonar, ...7.0107

MAGNETIC AND GRAVITY PREDICTION ...Geomagnetic Field, Magnetic Sensor, Noise, ...4.0044

EVALUATION OF CONTEMPORARY ACOUSTIC, MAGNETIC AND GRAVIMETRIC METHODS FOR DETERMINING SIZE AND SHAPE OF DEPOSITS ...Geophysical Equipment, Gravity Studies, Instrumental Services, Sonar, Survey Studies, ...7.0007

TESTING AND EVALUATION OF MAGNETOMETER/GRADIOMETER AND TOW VEHICLE SYSTEM ...Evaluation Other, Field Testing, Instrumental Services, Ore Deposits, Placer, ...8.0116

Seismic Studies

PARTIAL SUPPORT OF A PROGRAM OF EDUCATION & RESEARCH IN MARINE SEISMOLOGY AND GEOMAGNETICS ...Magnetic Studies, Training Grants, Fellowships, ...7.0127

HIGH-POWER HYDROACOUSTIC VIBRATOR DEVELOPMENT ...Generation, Liquids, Sonar, ...8.0165

A SHIPBOARD DIGITAL DATA ACQUISITION SYSTEM ...Data Acquisition, Systems Analysis, Tape Storage, ...4.0036

SUBMARINE GEOLOGY OF GASTINEAU CHANNEL JUNEAU, ALASKA ...Alaska, Basins, Distribution, Size, Subbottom, ...7.0191

SUBMARINE SEISMIC PROFILES OF THE WORLDS OCEANS ...Atlantic Ocean-general, Cables and Transmission Lines, Data Analysis - General, Indian Ocean-general, Subbottom, ...7.0150

LOW NOISE MULTI-CHANNEL HYDROPHONE CABLE ...Amplifiers, Bathymetry, Cables and Transmission Lines, Telephone, Transmission Lines, ...8.0145

SEISMOLOGICAL RESEARCH RELATED TO WORLD-WIDE SEISMIC DATA ...Earthquakes, Propagation, Rift, Structure Location, Surface, ...7.0141

RESEARCH IN MARINE GEOLOGY ...Bathymetry, Data Analysis - General, Gravity Studies, Magnetic Studies, Ships and Cruises, ...4.0027

STUDY OF EARTH NOISE ON LAND AND SEA BOTTOM ...Microseisms - Background, Ocean Basins, Propagation, Structural Studies, ...7.0094

MARINE GEOPHYSICS ...Crust, Field Characteristics-general, Gravity Studies, Gulf of Mexico, Physical Properties, ...7.0149

SUPPORT OF RESEARCH VESSELS JOHN ELLIOTT PILLSBURY, GERDA, TURSIOPS ...Microfossils, Mineralogy, Paleotemperature, Petrology, Ships and Cruises, ...12.0024

MOHOLE SITE STUDIES ...Coring and Dredging, Earth Interior, Hawaii, Pacific Ocean-north, Structure Location, ...7.0097

DETAILED STUDY OF THE OCEANIC CRUST BY MEANS OF DEEP SEISMIC PROFILING ...Continental Shelves, Heat Flow Measurements, Subbottom, Textures-structures, Washington, ...7.0152

DIGITIZING SYSTEM FOR OCEANOGRAPHIC DATA ...Analog-digital Converters, Applied Electronics, Bathymetry, Digital Computers, Instrumental Services, Spectral Analysis, ...4.0039

DEEP EARTHQUAKES AND ISLAND-ARC TECTONICS AND STRUCTURE ...American Samoa, Attenuation, Earthquake Location, Earthquakes, Island-arcs, Velocity Variations, ...7.0140

SUPPORT OF RESEARCH VESSEL AT LAMONT GEOLOGICAL OBSERVATORY ...Distribution, Marine Biology, Patterns, Ridges, Ships and Cruises, ...12.0037

GEOLOGICAL AND GEOPHYSICAL INVESTIGATION OF THE BAHAMA BANK ...Banks, Bathymetry, British West Indies, Crust, Magnetic Studies, ...7.0110

COLLECTION, REDUCTION, AND INTERPRETATION OF SEISMOLOGIC AND PHOTOGRAPHIC DATA ...Data Analysis - General, Distribution, Environment, Ocean Basins, Photography, Sedimentary History, Sedimentation, ...7.0262

LAKE SUPERIOR CORING III ...Core Analysis, Lake Superior, Sedimentology-general, Subsurface, Textures-structures, ...7.0247

MARINE GEOPHYSICS ...Acoustical, Continental Shelf, Continental Slope, Mechanical Devices, Textures-structures, ...7.0146

MARINE GEOPHYSICAL STUDIES IN THE PACIFIC OCEAN ...Crust, Gravity Studies, Magnetic Studies, Ocean Basins, Solomon Islands, ...7.0113

STUDIES OF EARTHQUAKES IN THE CAPE MENDOCINE AREA ...Applied Electronics, Data Transmission Systems, Earthquake Location, Earthquakes, Telemetry-other, ...7.0088

GRAVITY SURVEY ARCTIC OCEAN ...Bathymetry, Beaufort Sea, Continental Shelf, Geodetic Surveys, Gravity Studies, Structural Studies, ...7.0154

RESEARCH IN OCEAN PROPERTIES ...Acoustical, Geomorphology-topography, Geophysical Equipment, Marine Biology, Model Studies, Subbottom, ...7.0132

RESEARCH IN OCEANOGRAPHIC SPECIAL CHARTS ...Acoustical, General Sediment Type, Geomorphology-topography, Model Studies, Seismic Reflection, Subbottom, ...1.0062

ARCTIC RESEARCH LABORATORY ...Acoustical, Alaska, Arctic Ocean, Drift Stations, Terrain Analysis, ...12.0003

RESEARCH IN REGIONAL TOPOGRAPHIC ANALYSIS ...Acoustical, Geomorphology-topography, Sonar, Subbottom, ...1.0063

GEOPHYSICS, GULF OF MEXICO ...Gulf of Mexico, Ocean Basins, Regional Structure, Structural Studies, Trenches, ...7.0148

DEVELOPMENT OF ANALYSIS TECHNIQUES FOR CLASSIFYING TRANSIENT HYDROACOUSTIC SIGNALS ...Acoustical, Acoustics, Signal Detection, Transient, ...1.0068

OCEANOGRAPHIC RESEARCH ...Acoustical, Buoys, Currents-ocean, Optical, Pressure, Sonar, ...1.0151

ACOUSTIC PROPERTIES OF SEDIMENTS ...Acoustical, Correlation, Physical Properties, Subbottom, Texture, ...7.0108

ADVANCED TECHNOLOGY AND BOTTOM PREDICTIONS ...Acoustical, Benthonic-bottom, Data Acquisition, Data Analysis - General, Forecasting-prediction, Model Studies, ...1.0045

GLOBAL OCEAN FLOOR ANALYSIS ...Acoustical, Bathymetry, Benthonic-bottom, Currents-bottom, Geomorphology-topography, Subbottom, ...4.0046

Geophysics-general

ARCTIC BIBLIOGRAPHY PROJECT ...Arctic, Bibliography, Meteorological Studies-general, Oceanography-general, ...11.0013

CONFERENCE REPORTS ...Marine Biology, Meetings, Tables, Compilations, Catalogs, ...11.0034

ARCTIC FIELD RESEARCH ...Arctic Ocean, Bibliography, Environmental Effects-geologic, Russia, ...11.0011

Georgia

FIELD EXPERIMENTS ON THE FLUX OF RADIONUCLIDES THROUGH A SALT MARSH ECOSYSTEM ...Chlorideae (non-specific & Ot), Model Studies, Productivity - Food Chain, Swamps-marshes, Water Cycle, ...5.0965

THE POTENTIAL SOURCE, TRANSPORT AND DEPOSITIONAL PATTERNS OF CLASTIC SEDIMENTS IN PORTIONS OF COASTAL GEORGIA ...Beach, Currents-longshore, General Mineralogic Properties, Microstructure, Size, ...7.0235

ESTIMATE OF STANDING CROP OF OYSTERS AND SURVEY OF OYSTER PREDATORS IN GEORGIA ...Censusing, Oysters, Predation, ...5.0416

DETERMINATION OF THE STRUCTURE & ECONOMIC IMPORTANCE OF THE VARIOUS SEGMENTS OF THE SEAFOOD INDUSTRY ...Commercial Fishing, Consumer Pref. & Consumption, Fish & Shellfish, Fish -non-specific, Production & Processing, Regional Economic Impact, Shellfish -non-specific, ...4.0180

SURVEY OF A POTENTIAL HARD CLAM FISHERY ...Clams, Commercial Fishing, Coring and Dredging, Estuaries, Spawning & Nesting Sites, ...5.0420

ESTIMATING THE VALUE ADDED TO SEAFOOD PRODUCTS LANDED IN GEORGIA AT THE VARIOUS STAGES OF THE MARKETING CHANNEL ...Fish -non-specific, Processing, Quality -non-specific, Shellfish -non-specific, ...6.0020

ECOLOGY OF KRAFT PAPER MILL EFFLUENT IN SAPELO & ST. CATHERINES SOUNDS, GA ...Aquatic Ecology, Pollution - Effects of , Pollution Effects, Pulp, Paper , and Logging, Streams, ...5.0886

HYDROLOGY OF COASTAL AREA IN THE VICINITY OF RICEBORO, GEORGIA ...Aquifers, Artesian Flow, Dispersion - water, Estuaries, Saline Water Intrusion, Water Quality-general, ...9.0007

Geothermal

A STUDY OF THE TEMPERATURE MICROSTRUCTURE AND EDDY TRANSPORT IN THE OCEAN FLOOR BOUNDARY LAYER ...Benthonic-bottom, Heat Flow Measurements, Physical Analysis, Temperature, Thermodynamics, ...1.0189

GEOTHERMAL INVESTIGATIONS IN OCEAN REGIONS ...Atlantic Ocean-general, Heat Flow Measurements, Model Studies, Regional Structure, Technique Development, ...7.0121

GEOTHERMAL STUDIES IN DEEP-SEA DRILL HOLES ...Abyssal, Bathyal, Borehole Geophysics, Core Temperature, Earth Interior, Heat Flow Measurements, Heat Flows, Sediments-general, Technique Development, ...7.0122

SEAMOUNT INVESTIGATION ...Anomalies, Data Analysis - General, Magnetic Studies, Ocean Mining, Seamounts-guyots, Sonar, ...7.0107

Germ Free Animal

NUTRITION AND PHYSIOLOGY OF MARINE FISH IN CONTROLLED GNOTOBIOTIC ENVIRONMENTS ...Aquaria, Environmental Physiology, Fish -non-specific, Nutrition -other, ...5.0317

GERMFREE FISH ...Captive Rearing, Fish -other, Immunology, Infectious Conditions and Dis, Vertebrate Anatomy, ...5.0236

INSPECTION OF OYSTER SEED - NEW ASIATIC SOURCES ...Captive Rearing, Commercial Fishing, Japan, Oysters, ...5.0511

Glacial Environment

WEST GREENLAND GLACIER SURVEY ...Greenland, Icebergs, Movement, Photography, Types, ...3.0077

Glacial Features

Erosional Features

Erosional Features-general

UNDERWATER GEOLOGY IN THE OSWEGO AREA OF LAKE ONTARIO ...Erosional Features, Geology-general, Lake Ontario, Photography, Sedimentary Structures-other, ...7.0044

Fjords

LONG PERIOD WAVES ...Hydrodynamics, Iceland, Seiches, Tides, Waves, ...2.0108

FIORD OCEANOGRAPHY ...Alaska, Estuaries, Hydrodynamics, Model Studies, Simulation Theory, ...4.0040

QUATERNARY OF THE HUDSON RIVER ESTUARY ...Estuaries, Hudson River, Paleoenvironments, Quaternary Period, Valleys and Canyons, ...7.0256

Glaciers

Deposits

CLAY-INORGANIC AND ORGANIC-INORGANIC ASSOCIATIONS IN AQUATIC ENVIRONMENTS ...Clays, Mineral Reactions, Sedimentation, Suspension, Trace Elements, ...7.0050

DEPOSITIONAL PROCESSES MARGINAL TO LARGE ANTARCTIC ICE SHELVES ...Antarctic Ocean, Core Analysis, Environment, Sedimentary History, Sedimentation, ...7.0198

NEARSHORE HEAVY METAL DEPOSITS OF THE GULF OF ALASKA ...Distribution, Gulf of Alaska, Heavy Minerals, Mineral Concentration, Sedimentation, ...7.0019

Movement

WEST GREENLAND GLACIER SURVEY ...Glacial Environment, Greenland, Icebergs, Photography, Types, ...3.0077

Types

WEST GREENLAND GLACIER SURVEY ...Glacial Environment, Greenland, Icebergs, Movement, Photography, ...3.0077

Water

INTERSTITIAL WATER OF GLACIAL-MARINE SEDIMENT ...Alaska, Estuaries, Glacial Clastics, Interstitial - Connate Water, Water Supply-general, ...**7.0188**

Glaciology-general

ARCTIC FIELD RESEARCH ...Arctic, Geology-general, Marine Biology, Micrometeorology, ...**11.0010**

Glycolic Acid

ENVIRONMENTAL EFFECTS ON THE METABOLISM OF MARINE ALGAE ...Enzymes, Laminariaceae (non-specif.&ot), Light, Marine Plants, Phytoplankton, Responses to Growth, ...**5.0702**

Glyoxal

CELL DIVISION, BIOENERGETICS, CHEMISTRY OF MUSCLE ...Bioenergetics, Cell Cycle, Configuration, Organic, ...**5.0987**

Gravimetric Instrumentation

Airborne Gravimeters

GEOPHYSICAL SURVEYING AND CHARTING ...Data Acquisition, Development of Models, Gravity Studies, Mapping, Platforms, ...**7.0106**

Dynamic Gravimeters

OCEAN BOTTOM EMPLACED GEOPHYSICAL STATION ...Automatic Stations, Benthonic-bottom, Geophysical Equipment, Gravity Studies, Instrumental Services, Pacific Ocean-east, Temperature, Water Motion Recorders, ...**4.0035**

MARINE GRAVITY ...Geophysical Equipment, Navigation, Ships and Cruises, Technique Development, ...**8.0101**

General Gravimeters

GRAVITY AND EARTH TIDES ...Antarctica, Earth Interior, Earth Tides, Propagation, Tides, ...**2.0077**

Gravity Studies

Applications

Structural Analysis

ACQUISITION AND INTERPRETATION OF OCEANIC GRAVITY DATA ...Analog Computer Applications, Data Reduction and Analysis, Gravity Studies, Ridges, Trenches, ...**4.0033**

Exploration Methods

Gravity Surveys

MARINE GRAVITY ...Gravity Studies, Navigation, Satellites, Variations, ...**4.0107**

GEOPHYSICAL INVESTIGATIONS IN THE TAIWAN-PHILIPPINE-NEW GUINEA REGION ...Basins, Heat Flow Measurements, Magnetic Surveys, Seismic Refraction, Seismic Surveys, ...**7.0129**

GEOPHYSICAL STUDIES FROM ELTANIN IN 1968 ...Antarctic Ocean, Paleomagnetism, Sea Floor Spreading, Seismic Reflection, Textures-structures, ...**7.0133**

Field Characteristics

Anomalies

PACIFIC GRAVITY ...Crust, Earth Interior, Geophysical Equipment, Gravity Studies, Pacific Ocean-north, ...**7.0144**

GRAVITY ...Caribbean Sea, Geophysical Equipment, Gravity, Navigation, Pacific Ocean-west, ...**7.0142**

GEOMAGNETIC INVESTIGATIONS ...Gravity Studies, Magnetometers, Ridges, Sea Floor Spreading, Structural Studies, ...**7.0120**

Field Characteristics-general

MARINE DIGITAL GRAVITY PROFILING SYSTEM ...Digital Computer Applications, Gravity Studies, Navigation, Special Mission Ships, ...**4.0038**

MARINE GEOPHYSICS ...Crust, Gravity Studies, Gulf of Mexico, Physical Properties, Seismic Studies, ...**7.0149**

Variations

MARINE GRAVITY ...Gravity Studies, Gravity Surveys, Navigation, Satellites, ...**4.0107**

GRAVITY FIELD AT SEA ...Gravity Studies, Navigation, Pacific Ocean-south, Ships and Cruises, ...**7.0098**

Great Lakes

Great Lakes-general

LAKE EFFECT SNOWSTROM STUDY ...Direction, Modification, Nucleation Physics, Orographic Effects, Patterns, ...**3.0052**

FULL SCALE STRESS MEASUREMENT TESTS OF GREAT LAKES ORE CARRIER ...Hull, Other-design-and-construction, Testing Structural, Waves, ...**8.0320**

SUPPORT OF TWO RESEARCH VESSELS ...Air-sea Boundary-general, General Sea Water Chemistry, Marine Biology, Ships and Cruises, Water Properties-general, ...**12.0034**

HYDROLOGIC SYSTEMS ANALYSIS OF THE GREAT LAKES ...Discharge, Inflow, Water Storage, ...**4.0076**

VERTICAL CURRENT STRUCTURE IN THE GREAT LAKES ...Circulation-general, Temperature, ...**2.0033**

BIG EDDIES AND MIXING PROCESSES IN THE GREAT LAKES ...Circulation -water, Dispersion -water, Effluents-waste Water, Mixing, Water Motion, ...**2.0052**

MINERAL-WATER CHEMISTRY, GREAT LAKES ...Chemical Reactions, Mineral Equilibra, Mineral Genesis, Model Studies, Phase Relationships, Solution Chemistry, ...**1.0117**

BOTULINUM FOOD POISONING IN RELATION TO FISHERY PRODUCTS ...Antibiotics, Clostridium Botulinum, Fish -non-specific, Microbiological, Repression, ...**6.0087**

GREAT LAKES RESEARCH - ICE COVER DISTRIBUTION ...Aerial Photography, Aerospatial, Alteration, Petrofabrics, Sea Ice, ...**3.0083**

GREAT LAKES RESEARCH - LAKE PRECIPITATION ...Amount, Forecasting, Lake Erie, Lake Michigan, Meteorological Studies, ...**3.0065**

GREAT LAKES RESEARCH - CHARACTERISTICS OF LAKE WATER ...Chemical-general, Meteorological Studies, Ocean Currents-other, Physical-general, Water Quality-general, ...**1.0154**

GREAT LAKES RESEARCH - COASTAL AREA SEDIMENTATION ...Beach, Development, Energy, General Transport Effects, Model Studies, Sedimentation, ...**7.0124**

GREAT LAKES RESEARCH - LAKE WAVES ...Shear, Water Motion Recorders, Waves, Wind-water Interaction, ...**2.0118**

GREAT LAKES RESEARCH - HARBOR CURRENTS ...Harbors, Model Studies, Ocean Currents-other, Pressure-density, Water Level Fluctuation, Wind-water Interaction, ...**2.0074**

GREAT LAKES RESEARCH - SPOIL DISPOSAL EFFECTS ...Dispersion -water, Pollution - Effects of , Sediments, Spoil Banks, Suspension, Water Properties-general, ...**6.0157**

GREAT LAKES RESEARCH - RIVER ICE JAMS ...Ice Jam, Streams, Survey Studies, Water Motion, ...**3.0081**

GREAT LAKES RESEARCH - GREAT LAKES DEICING ...Alteration, Bibliography, Ice Properties-general, Origin, Sea Ice, ...**3.0084**

GREAT LAKES RESEARCH - MONITORING OF WATER CHARACTERISTICS ...Data Acquisition, Forecasting-prediction, Geophysical Analysis, Instrumentation-general, Temperature, ...**1.0185**

BIOLOGY OF THE LARVAL SEA LAMPREY ...Control of Nuisance Species, Developmental Physiology, Environmental Ecology, Lampreys, Life History Studies, ...**5.0633**

DEVELOPMENTAL MORPHOLOGY OF COREGONIDS ...Aquatic Ecology, Bonneville Cisco, Cisco, Lake Herring, Developmental Physiology, Vertebrate Anatomy, ...**5.0274**

CHEMICAL CHARACTERISTICS OF THE GREAT LAKES ...Chemical Analysis (water), Nutrients, Productivity - Food Chain, Water Quality-general, ...**1.0116**

SEA LAMPREY AMMOCETE REESTABLISHMENT STUDIES ...Aquatic Ecology, Control of Nuisance Species, Lampreys, Larvicides, Life History Studies, Population Dynamics, ...**5.0629**

GREAT LAKES GEAR RESEARCH ...Commercial Fishing, Fish -non-specific, Fishing Gear, Lakes, Population Dynamics, ...**8.0136**

RESEARCH ON THE MACROBENTHOS OF THE GREAT LAKES ...Aquatic Ecology, Benthic Fauna, Earthworms, Food Supply, Water Quality-general, ...**5.0626**

MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES ...Fish -non-specific, Insecticides -non-specific, Monitoring Systems, Pollutants-general, Sampling, ...**6.0120**

ESTABLISHMENT AND PERPETUATION OF STOCKS OF EXPERIMENTAL FISH ...Behavior, Environmental Ecology, Environmental Physiology, Fish -non-specific, Life History Studies, ...**5.0109**

GREAT LAKES EXPLORATIONS ...Commercial Fishing, Fish -non-specific, Fishing Gear, Population Dynamics, ...**5.0108**

FISH HOLDING AND LIFE STAGE SENSITIVITY STUDIES ...Contamination - Water, Environment Resistance, Fish, Fish -non-specific, Maturity & Growth Stages, ...**5.0276**

PLANKTON REARING, ENVIRONMENTAL REQUIREMENTS AND SENSITIVITY STUDIES ...Algal Culture, Bioindicators, Microbiological Analysis, Plankton (non-specific), Water Quality-general, ...**5.0804**

ECOLOGY OF CLOSTRIDIUM BOTULINUM TYPE E IN GREEN BAY ...Fish -non-specific, Microbiological, ...**5.0850**

Lake Erie

CALORIC - AN INVESTIGATION OF HEAT RELEASE PATTERNS ASSOCIATED WITH PRESENT AND PLANNED LAKESHORE ELECTRICAL POWER PLANTS ...Electric Power Plants, Model Studies, Nuclear Power, Pollution - Effects of , Temperature, Thermal Pollution, ...**1.0186**

USE OF THE COASTAL ZONE FOR THE U. S. COASTLINE OF LAKE ERIE AND LAKE SUPERIOR ...Lake Superior, Lakeshores-inlets, Land Use, Social Aspects, Welfare Economics, ...**9.0004**

INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...Adsorption Capacity, Chemical, Eutrophication, Microorganisms (non-specific), Pollution - Effects of , Sediments, ...**6.0169**

CLADOPHORA AS RELATED TO POLLUTION IN WESTERN LAKE ERIE ...Algal Pollutant Sources, Bioindicators, Chemical Analysis, Cladophora, Mapping, ...**6.0170**

RELATIONSHIPS BETWEEN PHOSPHATE AND OTHER CHEMICALS AT THE WATERSUBSTRATE INTERFACE IN WESTERN LAKE ERIE ...Aquatic Soils, Chemical, Chemical-general, Phosphate, Phosphite, Sediments, ...**7.0078**

THE ECOLOGIC IMPACT OF THE INTERACTIONS AMONG MICROORGANISMS AND AQUATIC CONTAMINANTS IN LAKE ERIE ...Pollution - Effects of , Primary Productivity, Responses to Growth, Sediments, Water Bacteria, ...**5.0819**

DYNAMIC MODEL STUDY OF LAKE ERIE ...Hydraulics-general, Inflow, Model Studies, Synthetic Hydrology, ...**4.0075**

CONSTRUCTION OF A FACILITY TO DEMONSTRATE OFF-SHORE UNDERWATER TEMPORARY STORAGE OF STORM OVERFLOW FROM A COMBINATION SEWER ...Combined Sewer, Elastomers, Rubber, Storm Water, Tank, Pressure Vessel, Water Storage, ...**8.0328**

GREAT LAKES RESEARCH - LAKE PRECIPITATION ...Amount, Forecasting, Great Lakes-general, Lake Michigan, Meteorological Studies, ...**3.0065**

GREAT LAKES RESEARCH - WATER-LEVEL DISTURBANCES ...Lake Michigan, Model Studies, Sea Level Variations, Seiches, Water Level Fluctuation, ...**2.0086**

THE EFFECTS OF ENVIRONMENTAL CONDITIONS ON THE SPAWNING AND SURVIVAL OF FRY OF THE WALLEYE ...Environmental Effects-geologic, Eutrophication, Pollution - Effects of , Temperature, Walleyes, ...**5.0299**

ROUTINE SAMPLING AT SEVEN INDEX STATIONS ...Bottom Sampling, Data Acquisition, Fish -non-specific, Plankton Sampling, Sampling, ...**5.0214**

FLUCTUATIONS IN SPECIES COMPOSITION AND YEAR-CLASS STRENGTH OF COMMERCIAL LANDINGS ...Commercial Fishing, Lakes, Scales, Size, Species, Comparison of , ...**5.0135**

ENVIRONMENTAL CHANGES IN LAKE ERIE ...Aquatic Ecology, Environmental Changes, Environmental Ecology, Ions and Gases, Nutrients, ...**5.0903**

PLANKTON AND BENTHOS COMMUNITIES OF THE GREAT LAKES ...Aquatic Ecology, Benthic Organisms (non-specif), Gastropods -slugs,conch,snails, Lugworms, Marine Segmentedworm, Plankton (non-specific), ...**5.0801**

CHEMISTRY OF THE HYPOLIMNION OF LAKE ERIE ...Chemical-general, Ions and Gases, Overturn, Oxygen, Stratification, ...**1.0115**

QUANTITATIVE AND QUALITATIVE CHARACTERISTICS OF MATERIALS CONTRIBUTING TO SEDIMENTATION IN LAKE ERIE ...Location, Organic, Organics, Rate of Deposition, Sedimentation, ...**7.0246**

DISTRIBUTION AND ABUNDANCE OF ZOOPLANKTON IN LAKE ERIE ...Aquatic Ecology, Computer Applications, Environmental Ecology, Interbiotic Relat.(non-specif), Population Dynamics, ...**5.0802**

Lake Huron

STRONTIUM ISOTOPE COMPOSITION AND TRACE ELEMENT CONCENTRATIONS IN LAKE HURON AND ITS PRINCIPAL TRIBUTARIES ...Chemical, Ions and Gases, Rocks - Bedrock, Strontium, Trace Element Analysis, ...**1.0124**

LAKE HURON CHEMICAL CONTROL ...Bioindicators, Chemical-general, Ectoparasites, Flow Characteristics -water, Selectivity, ...**6.0159**

Lake Michigan

GEOLOGICAL STUDIES IN NORTHERN LAKE MICHIGAN ...Deposits-other, Lakes, Rocks - Bedrock, Submergent, Water Level Fluctuation, ...**7.0164**

STUDY OF INFLUENCE OF STRATIFICATION ON CURRENT STRUCTURE ...Circulation-general, Currents-other, Hydrodynamics, Stratified Flow, ...**2.0035**

PLANKTON ECOLOGY ...Aquatic Ecology, Copepods, Plankton Sampling, Ships and Cruises, Zooplankton, ...**5.0803**

ECOLOGY OF COMMERCIAL FISH SPECIES IN NORTHERN LAKE MICHIGAN ...Commercial Fishing, Fish -non-specific, Number Or Density, Population Dynamics, Vertical Distribution, ...**5.0112**

GREAT LAKES RESEARCH - LAKE PRECIPITATION ...Amount, Forecasting, Great Lakes-general, Lake Erie, Meteorological Studies, ...**3.0065**

GREAT LAKES RESEARCH - ENERGY TRANSFER AT THE AIR-WATER INTERFACE ...Data Analysis - General, Heat and Radiation Transfer, Heat-transfer-other, Mass Transfer, Towers, Wind-water Interaction, ...**3.0029**

GREAT LAKES RESEARCH - WATER-LEVEL DISTURBANCES ...Lake Erie, Model Studies, Sea Level Variations, Seiches, Water Level Fluctuation, ...**2.0086**

PHYSIOLOGY AND BEHAVIOR ...Behavior, Chemical Measurements -water, Environmental Physiology, Physical Measurements -water, Productivity - Food Chain, ...**5.0904**

POPULATION STRUCTURE OF THE ALEWIFE AND COREGONIDS ...Alewife,menhaden,shad,herring, Aquatic Ecology, Cisco, Lake Herring, Environmental Ecology, Population Dynamics, ...**5.0106**

LAKE MICHIGAN CHEMICAL CONTROL OF SEA LAMPREY ...Animal Pollutant Sources, Control of Nuisance Species, Evaluation, Lampreys, Larvicides, ...**6.0158**

ELECTRIC BARRIER OPERATIONS ...Control of Nuisance Species, Lake Superior, Lampreys, Migration, Population Dynamics, ...**5.0630**

RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...Fish, Insecticides -non-specific, Lake Superior, Lake Trout, Brook Trout, Pollution Effects, Salmon -coho,chinook,sockeye.., ...**6.0154**

INTERRELATIONS OF ALEWIVES AND ASSOCIATED SPECIES ...Alewife,menhaden,shad,herring, Behavioral Ecology, Competition, Predation, Vertical Distribution, ...**5.0111**

MESOSCALE WIND SYSTEMS AROUND THE GREAT LAKES ...General Synoptic Observations, Land-sea Breezes, Meteorologic Model Studies, Patterns, Pollution Behavior-general, ...**3.0064**

Lake Ontario

POTENTIALLY-ECONOMIC SAND AND SILT DEPOSITS IN LAKE ONTARIO, NEW YORK ...Geologic Maps, New York, Potential of Deposit, Sands and Gravels, Submergent, ...**7.0024**

UNDERWATER GEOLOGY IN THE OSWEGO AREA OF LAKE ONTARIO ...Erosional Features, Erosional Features-general, Geology-general, Photography, Sedimentary Structures-other, ...**7.0044**

FACTORS EFFECTING RATES OF ORGANIC DEPOSITION AND QUALITY OF WATER ...Clays, Organic Digestion, Organic Matter, Rate of Deposition, Swamps-marshes, ...**7.0261**

Lake Superior

LAKE SUPERIOR CORING III ...Core Analysis, Sedimentology-general, Seismic Studies, Subsurface, Textures-structures, ...7.0247

USE OF THE COASTAL ZONE FOR THE U. S. COASTLINE OF LAKE ERIE AND LAKE SUPERIOR ...Lake Erie, Lakeshores-inlets, Land Use, Social Aspects, Welfare Economics, ...9.0004

A STUDY OF THE OPEN WATER DISTRIBUTION AND ABUNDANCE OF NET-PLANKTON AS AN INDEX OF EUTROPHICATION IN LAKE SUPERIOR ...Bioindicators, Data Acquisition, Eutrophication, Plankton Sampling, Zooplankton, ...6.0160

INVESTIGATION OF THE CIRCULATION OF LAKE SUPERIOR ...Circulation-general, Model Studies, Stratified Flow, Temperature, Thermodynamics, Water Motion, ...2.0048

INVESTIGATION OF COMMERCIAL FISH POPULATIONS IN WESTERN LAKE SUPERIOR ...Alewife,menhaden,shad,herring, Commercial Fishing, Lakes, Nets, Population Dynamics, ...5.0113

GREAT LAKES RESEARCH - ICE CHARACTERISTICS ...Aerial Photography, Micrometeorology, Origin, Petrofabrics, Radiation-terrestrial, Sea Ice, ...3.0082

INTERRELATIONS OF SMELT WITH NATIVE SPECIES ...Competition, Food Supply, Life History Studies, Number Or Density, Smelts, ...5.0182

CHARACTERISTICS OF LAKE SUPERIOR WHITEFISH ...Commercial Fishing, Interbiotic Relat.(non-specif), Life History Studies, Salmon & Trout - Non-specific, Tags, ...5.0183

LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...Aquatic Ecology, Control of Nuisance Species, Lampreys, Larvicides, Streams, ...5.0628

ELECTRIC BARRIER OPERATIONS ...Control of Nuisance Species, Lake Michigan, Lampreys, Migration, Population Dynamics, ...5.0630

LAKE SUPERIOR EXPLORATIONS ...Commercial Fishing, Management -other, Nets, Smelts, Suckers, ...5.0107

LIFE HISTORY OF THE BURBOT AND LONGNOSE SUCKER ...Codfishes, Hake, Lakes, Life History Studies, Suckers, ...5.0184

RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...Fish, Insecticides -non-specific, Lake Michigan, Lake Trout, Brook Trout, Pollution Effects, Salmon -coho,chinook,sockeye.., ...6.0154

EFFECTS OF HIGH TEMPERATURE, LOW OXYGEN, AND PH EXTREMES ON THE SURVIVAL OF AQUATIC INSECTS AND CRUSTACEA IMPORTANT AS TROUT FOOD ...Aquatic Ecology, Food Supply, Gases, Dissolved -water, High Temp. -85f Or Above, Ph, Acidity -water, ...5.0464

Greece

A STUDY OF THE LEAD OXYCHLORIDES AND RELATED SPECIES FOUND IN THE ANCIENT SLAGS OF LAURIUM, GREECE ...Chemical Reactions, Discriptions of Minerals, Mine Wastes, Mineral Genesis, Silver, ...7.0058

Greenland

WEST GREENLAND GLACIER SURVEY ...Glacial Environment, Icebergs, Movement, Photography, Types, ...3.0077

MEASUREMENT OF COMMON LEAD IN THE EARTHS HYDROSPHERE ...Atomic Absorption, Composition, Isotope Dilution, Lead, Other Sources, ...3.0069

Groundwater

SOLUTION-SILICATE REACTIONS AND EQUILIBRIA ...Chemical Reactions, Chemistry, Equilibrium - Chemical, Reaction-general, Silicate-general, Solution, Solution Chemistry, ...1.0097

NUMERICAL SIMULATION OF HYDRODYNAMIC PHENOMENA BY DIGITAL COMPUTER ...Model Studies, Open Channel Flow, Porous Media - Flow Through, Subsurface Flow, Waves, ...4.0083

Groundwater Features

Thermal Features

DEEP OCEAN AS RECIPIENT OF VOLATILES AND SOLUTES ...Hydrothermal Minerals, Igneous Activity - Volcanism, Lithology, Pacific Ocean-east, Ridges, Sea Floor Spreading, Water Analysis-general, ...7.0095

Groundwater Movement

DISPERSION IN HYDROLOGIC AND COASTAL ENVIRONMENTS ...Dispersion -water, Ocean, Shoreline - Coastline, Stratified Flow, Turbulent Flow, ...2.0051

HYDROLOGY OF UPPER OLD TAMPA BAY, FLORIDA ...Bays, Hydrology-general, Lakes, Permeability, Water Harvesting, Water Quality-general, ...2.0067

Guinea

HYPERIID AMPHIPODS FROM THE GULF OF GUINEA ...Animal Taxonomy, Collections, Oceanography-general, Shrimp - Amphipods, Vertical Distribution, ...5.0387

Gulf of Aden

GEOPHYSICAL AND GEOCHEMICAL STUDY OF RED SEA MINERAL DEPOSITS ...Coring and Dredging, Igneous Activity - Volcanism, Mineralogy, Red Sea, Thermal, ...7.0023

Gulf of Alaska

TAGGING SALMON IN THE OFFSHORE WATERS OF THE NORTH PACIFIC ...Bering Sea, Migration, Number Or Density, Range Or Territorial Distr. , Salmon & Trout - Non-specific, Tags, ...5.0180

NEARSHORE HEAVY METAL DEPOSITS OF THE GULF OF ALASKA ...Deposits, Distribution, Heavy Minerals, Mineral Concentration, Sedimentation, ...7.0019

GULF-PENINSULA KING CRAB STUDIES ...Commercial Fishing, Crabs, Habitat Studies, Population Dynamics, ...5.0342

GULF OF ALASKA DEMERSAL FISH INVESTIGATIONS ...Fish -non-specific, Population Dynamics, Productivity (agricultural), Vertical Distribution, ...5.0009

MARINE BIOLOGICAL INVESTIGATIONS - JAPANESE FISHERY OBSERVERS PROJECT ...Commercial Fishing, Japan, Nets, Righteye Flounders, ...5.0012

BOTTOMFISH EXPLORATIONS ...Bering Sea, Fish -other, Nets, Vertical Distribution, ...5.0030

GULF OF ALASKA SOCKEYE SALMON SCALES, PROTOCOL AREA SOCKEYE SALMON SCALES, AND GULF OF ALASKA PINK SALMON SCALES ...Animal Taxonomy, Life History Studies, Salmon -coho,chinook,sockeye.., Scales, ...5.0334

Gulf of California

SUPPORT OF THE VERMILION SEA FIELD STATION AT BAHIA DE LOS ANGELES, BAJA CALIFORNIA ...Arid and Desert, Facilities, Habitat Studies, Temperature, Tides, ...12.0009

DISTRIBUTION OF THE MID-WATER FISHES OF THE GULF OF CALIFORNIA ...Environmental Ecology, Fish -non-specific, Nets, Organism Sampling Devices, Vertical Distribution, ...5.0043

DETECTION OF DEEP-SEATED ANOMALIES IN ELECTRICAL CONDUCTIVITY UNDER THE GULF OF CALIFORNIA ...Anomalies, Conductivity, Continental Drift, Heat Flows, Rift, ...7.0099

GULF OF CALIFORNIA BIOLOGY ...Arid and Desert, Bioluminescence, Intertidal Areas, Population Dynamics, Tropic, ...5.0856

Gulf of Mexico

SIMULATION MODELS OF SHALLOW-WATER AND COASTAL ENVIRONMENTS ...Computer Applications, Hydrology-general, Model Studies, Sedimentation, Shoreline - Coastline, ...4.0066

CIRCULATION STUDIES ...Circulation-general, Currents-ocean, Hydrodynamics, Mixing, Pacific Ocean-east, ...2.0042

SEDIMENTATION ...Acoustical, Gravity Tectonics, Mass Wasting, Mechanical Properties, Sedimentation, ...7.0281

CHEMICAL OCEANOGRAPHY ...Carbon, Carbon-14, Chemical Reactions, Organics, Reaction-general, ...1.0131

AIR-SEA INTERACTION ...Air-sea Boundary-general, Currents-ocean, Thermal, Tropical Cyclones, Weather Forecasting, ...3.0042

MARINE GEOPHYSICS ...Crust, Field Characteristics-general, Gravity Studies, Physical Properties, Seismic Studies, ...7.0149

HETEROTROPHIC ACTIVITY AND PRIMARY REGENERATION IN THE OCEAN ...Atlantic Ocean-south, Biodegradation, Carbon, Organics, Organics-general, ...1.0114

ECOLOGICAL EFFECTS OF ENVIRONMENTAL & LOW LEVEL POLLUTION STRESSES ON METABOLIC REQUIREMENTS FOR GROWTH OF GULF COAST FISHES ...Environmental Ecology, Metabolism, Pollution - Effects of , Pollution Effects, Pollution Sources-general, Stress, ...5.0328

COLLECTION AND INTERPRETATION OF OCEANIC THERMAL GRADIENTS ...Bathythermographs, Heat Flow Measurements, Pacific Ocean-east, Temperature, ...1.0187

SEA BREEZE INVESTIGATION ...Data Analysis - General, Energy-general, Heat and Radiation Transfer, Land-sea Breezes, Texas, ...3.0040

LIPID COMPOSITION OF ANTARCTIC MARINE ORGANISMS AND SEA WATER ...Antarctic Ocean, Fish -non-specific, Lipids, Low Temp. -but Above 32f, Phytoplankton, Productivity - Food Chain, Zooplankton, ...5.1031

SYMPOSIUM ON RESEARCH NEEDS AND PRIORITIES FOR MARINE GEOLOGY OF THE GULF OF MEXICO ...Continental Shelf, Instrumentation-general, Mechanical Properties, Meetings, Sedimentation, Structural Studies, ...11.0040

OPERATION OF R/V ALAMINOS ...Carbon, Caribbean Sea, Gulf Stream, Ships and Cruises, Textures-structures, ...12.0046

CIRCULATION IN THE GULF OF MEXICO ...Circulation-general, Currents-ocean, Infrared Radiation, Mapping, Oceanic Fronts, ...2.0022

DEEP SEA BENTHOS IN THE GULF OF MEXICO ...Benthic Fauna, Benthonic-bottom, Biology, Population Dynamics, ...5.0655

REMOTE SENSOR OCEANOGRAPHY ...Aerial Photography, Cloud Temperature, Infrared Radiation, Satellites, Surface Environments, Temperature, ...4.0170

BOTTOM ENVIRONMENT--GULF OF MEXICO ...Benthonic-bottom, Biology, Chemistry, Ocean Currents-other, Physical Properties, ...2.0043

CIRCULATION STUDIES ...Circulation-general, Currents-ocean, Model Studies, Thermal, Tropical Cyclones, ...2.0044

GEOPHYSICS, GULF OF MEXICO ...Ocean Basins, Regional Structure, Seismic Studies, Structural Studies, Trenches, ...7.0148

OYSTER LEASE CONTROL MONUMENTS - BAY ADAM, BASTIAN BAY AND SANDY POINT BAY AREAS ...Commercial Fishing, Louisiana, Oysters, Plane, Tides, ...4.0057

LAKE BORGNO - CHANDELEUR SOUND SYSTEM ...Data Acquisition, Maturity & Growth Stages, Nets, Plankton Sampling, Population Dynamics, Shrimps - Common, ...5.0434

HORIZONTAL DISPERSION IN SHALLOW ESTUARIES OF IRREGULAR SHAPE ...Circulation -water, Dispersion -water, Estuaries, Model Studies, Water Quality-general, ...2.0064

REFERENCE COLLECTION OF GULF MARINE ANIMALS ...Animal Taxonomy, Collections, Invertebrates -non-specific, Vertebrates -non-specific, ...5.0657

STUDY OF LIFE HISTORY AND ECOLOGY OF SERPULIDAE IN TEXAS COASTAL WATERS ...Life History Studies, Lugworms, Marine Segmentedworm, Texas, ...5.0656

THE TAXONOMY AND ZOOGEOGRAPHY OF THE POLYCHAETOUS ANNELIDS OF THE GULF OF MEXICO AND THE CARIBBEAN SEA ...Animal Taxonomy, Caribbean Sea, Lugworms, Marine Segmentedworm, Neotropical, ...5.0569

DISTRIBUTION OF HEAVY METALS, WESTERN GULF OF MEXICO ...Chemistry, Dimensions-distribution, Geophysics-general, Heavy Minerals, Ocean Mining, ...7.0013

MARINE GEOLOGY STUDIES, GULF OF MEXICO-CARIBBEAN REGION ...Dimensions-distribution, Distribution, Geology-general, Ocean Mining, Tectonics-general, ...7.0103

ECOLOGICAL STUDIES OF ATLANTIC AND GULF COASTAL ESTUARIES OF IMPORTANCE TO WATERFOWL ...Agricultural Land Use Effects, Atlantic Ocean-general, Construction Land Use Effects, Estuaries, Habitat Studies, Waterfowl -non-specific, ...5.0896

INVENTORY AND ATLAS OF GULF COAST SPORT FISHING FACILITIES ...Atlases-maps, Fishing, Handbooks, Management -other, ...9.0006

ENVIRONMENTAL EFFECTS ON ISTIOPHORID FISH DISTRIBUTION ...Environmental Ecology, Marlin, Billfishes, Sailfish.., Ships and Cruises, Temporal Distribution, ...5.0070

INVENTORY OF THE GULF ESTUARY SYSTEM ...Bays, Data Acquisition, Estuaries, Fishing, Sedimentology-general, ...4.0047

INVESTIGATION OF THE BIOLOGY AND POPULATION STRUCTURE OF GULF MENHADEN ...Alewife,menhaden,shad,herring, Bone, Handbooks, Population Dynamics, Vertebrate Anatomy, ...5.0128

ESTIMATION OF JUVENILE ABUNDANCE IN ESTUARINE NURSERIES ...Alewife,menhaden,shad,herring, Aquatic Ecology, Estuaries, Maturity & Growth Stages, Number Or Density, ...5.0131

CIRCULATION DYNAMICS (GULF OCEANOGRAPHY PROGRAM) ...Circulation-general, Environmental Changes, Shrimps - Common, Thermodynamics, ...2.0045

BIOLOGICAL OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM) ...Environmental Ecology, Food Supply, Productivity - Food Chain, Shrimps - Common, ...5.0838

EVALUATION OF ENGINEERING PROJECTS AND ESTUARINE DATA (ESTUARINE PROGRAM) ...Commercial Fishing, Engineering Structures-general, Estuaries, Habitat Studies, Swamps-marshes, ...9.0021

POPULATION DYNAMICS (SHRIMP DYNAMICS PROGRAM) ...Commercial Fishing, Mortality Rates, Nets, Population Dynamics, Shrimps - Common, ...5.0503

ECOLOGY OF WESTERN GULF ESTUARIES (ESTUARINE PROGRAM) ...Coastal Engineering-other, Estuaries, Habitat Studies, Mans Activities, Pollution - Effects of , ...5.0928

LABORATORY STUDIES OF TOXIC DINOFLAGELLATES ...Algal Culture, Algal Toxins, Gonyaulax, Gymnodinium, Plant Origin, ...5.0837

Harbors

GENERATION, PROPAGATION, AND COASTAL EFFECTS OF TSUNAMIS ...Earthquakes, Propagation, Shoreline - Coastline, Shoreline Structures, Tsunami, ...2.0095

CRITERIA FOR THE DESIGN OF SMALL CRAFT HARBORS ...Breakwaters, Coastal Engineering-other, Marinas, Seiches, Waves, ...8.0036

MEASUREMENT OF SURGING IN KUHIO BAY, HILO HAWAII ...Gaging, Hawaii, Tsunami, Water Motion Recorders, Waves, ...2.0112

BARBERS POINT HARBOR MODEL STUDY ...Hawaii, Model Studies, ...4.0104

DESIGN OF RUBBLE WAVE-ABSORBER ...Beaches, Energy Dissipators, Measuring Devices-other, Shoreline Structures, Waves, ...8.0037

BACTERIOLOGICAL AND ESTHETIC OF PLEASURE BOAT WASTE DISCHARGE ON SMALL HARBORS ...Bacterial Pollutant Sources, Beautification, Marinas, Ship Wastes, Water Analysis, ...6.0191

THE POPULATION ECOLOGY OF GEMMA GEMMA (PELECYPODA, VENERIDAE), A DOMINANT SPECIES IN BARNSTABLE HARBOR, MASS ...Clams, Massachusetts, Population Dynamics, ...5.0460

FORAMINIFERA FROM HEDLEY HARBOR, MASSACHUSETTS ...Environmental Ecology, Foraminifera, Massachusetts, Number Or Density, Vertical Distribution, ...5.0563

TIDAL FLOWS IN RIVERS AND HARBORS ...Committee-support, Hydraulics-general, Streams, Tides, ...2.0087

HARBOR DESIGN STUDIES ...Navigation, Waves, ...8.0046

EFFECTS OF SCALE AND OPERATING TECHNIQUE ON HARBOR MODELS ...Synthetic Hydrology, ...4.0074

GREAT LAKES RESEARCH - HARBOR CURRENTS ...Great Lakes-general, Model Studies, Ocean Currents-other, Pressure-density, Water Level Fluctuation, Wind-water Interaction, ...2.0074

HISTORICAL STUDY ON EFFECT OF HARBOR DREDGING ON THE ENVIRONMENT (ENVIRONMENTAL FACTORS PERTINENT TO EFFECTS ON MARINE ENVIRONMENTS) ...Dredging, Environmental Effects-geologic, Excavation, Marine Environments-general, Ocean Mining, ...6.0135

TRACERS STUDIES IN ALASKAN HARBORS ...Estuaries, Flow Augmentation, Industrial Wastes, Tides, Tracers-general, ...2.0049

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HAWAIIAN OCEANOGRAPHY ...Circulation-general, Environmental Effects-geologic, Hydrodynamics, Islands, Ocean Currents-other, ...**2.0021**

PHYSICAL OCEANOGRAPHY ...Convection, Heat and Radiation Transfer, Mixing, Thermal, Wind-water Interaction, ...**3.0034**

THE SYSTEMATICS AND ZOOGEOGRAPHY OF THE BRYOZOAN FAUNA OF THE HAWAIIAN ISLANDS ...Animal Taxonomy, Australian, Bryozoa, Collections, Range Or Territorial Distr. , ...**5.0542**

POPULATION GENETICS AND LARVAL ECOLOGY OF HAWAIIAN LITTORINA ...Derivatives, Gastropods - slugs,conch,snails, Maturity & Growth Stages, Polymorphism, ...**5.0429**

RECENT AND ANCIENT FAUNAS OF A DROWNED ISLAND CHAIN (MID-PACIFIC MOUNTAINS) ...Benthic Fauna, Biofacies, Coring and Dredging, Seamounts-guyots, ...**5.0863**

TSUNAMI RUNUP EXPERIMENTS ON A SCALE MODEL OF OAHU ...Forecasting-prediction, Model Studies, Tsunami, ...**2.0111**

MOHOLE SITE STUDIES ...Coring and Dredging, Earth Interior, Pacific Ocean-north, Seismic Studies, Structure Location, ...**7.0097**

CARBON-14 AGE PROFILE OF A HAWAIIAN REEF ...Anthozoa, Carbon-14, Coring and Dredging, Growth Rate, Reefs, Sea Level Variations, ...**7.0051**

RADIOCARBON DATING OF A HAWAIIAN REEF PROFILE ...Carbon-14, Radioactive Dating, Reefs, Sea Level Variations, ...**7.0087**

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OPERATIONAL SUPPORT OF OCEANOGRAPHIC RESEARCH VESSELS ...Facilities, Geophysics-general, Sediments-general, Structural Studies, ...**12.0027**

MEASUREMENT OF SURGING IN KUHIO BAY, HILO HAWAII ...Gaging, Harbors, Tsunami, Water Motion Recorders, Waves, ...**2.0112**

BARBERS POINT HARBOR MODEL STUDY ...Harbors, Model Studies, ...**4.0104**

INTRODUCTION OF MARINE GAME FISHES FROM AREAS IN THE PACIFIC ...Diving and Scuba, Pacific Ocean-north, Stocking of Fish & Shellfish, ...**5.0075**

SEA SLED AND SCUBA RECONNAISSANCE OF INSHORE AND STUDIES ON EFFECT OF ARTIFICIAL SHELTERS ON STANDING CROP OF FISHES ...Coastlines-shorelines, Diving and Scuba, Fish -non-specific, Geomorphology-topography, Management -other ...**9.0008**

HAWAII STATE COMPREHENSIVE OUTDOOR RECREATION PLAN ...Inventories, Methods, Projected Demand, Recreation, Survey, User Characteristics, ...**9.0009**

BACTERIOLOGICAL STUDY OF THE POLLUTION OF KANEOHE BAY, OAHU ...Bays, Bioindicators, Coliforms (non-specific), Nitrogen, Sewage, Streptococcus Fecalis, ...**6.0150**

SPECTRAL ANALYSIS OF TIDAL CURRENTS ...Currents-other, Integral Transforms, Prediction, Tides, Time Series Analysis, ...**2.0083**

ALPINE LIMNOLOGY PROJECT ...Core Analysis, Dust - Particulate Matter, Extrusives, Lakes, Mountains-alpine, Volcanoes, ...**7.0236**

STUDY OF THIAMINASE IN HAWAII FISH ...Enzymatic, Enzyme Inhibitors, Fish -non-specific, Thiaminase, Toxicological and Allergy, ...**5.0260**

WESTERN PACIFIC ISLANDS ...Igneous Activity - Volcanism, Lava, Mapping, Petrology, Sea Level Changes, ...**7.0104**

INVESTIGATE FACTORS DETERMING DISTRIBUTION OF PHYSICAL AND CHEMICAL PROPERTIES OF THE PACIFIC OCEAN ...Currents-ocean, Mathematical Analysis, Model Studies, Oceanic Fronts, Pacific Ocean-general, ...**5.0888**

STUDY ASSOCIATION BETWEEN TRADE WIND SYSTEM AND NORTH PACIFIC OCENAOGRAPHIC CLIMATE ...Meteorological Studies, Ocean-lakes, Temperature, Waves, Wind-water Interaction, ...**3.0019**

INVESTIGATE SEASONAL VARIATIONS, SURFACE WATER TYPES, HAWAIIAN AREA (KOKO HEAD) ...Commercial Fishing, Heat and Radiation Transfer, Oceanic Fronts, Salinity, Temperature, Tuna, Mackerel, Albacore... , Water Salinity, Water Temperature-non-specific, ...**1.0148**

PROVIDE FOR ACTIVITIES OF TUNA BLOOD GROUP CENTER ...Blood Plasma and Serum, Blood Typing Studies, Immunology Methods, Tuna, Mackerel, Albacore... , ...**5.0258**

INCREASE EFFICIENCY OF HAWAIIAN SKIPJACK FISHERY ...Captive Rearing, Commercial Fishing, Food Supply, Tuna, Mackerel, Albacore... , ...**5.0077**

DETERMINE ALTERNATE LIVEBAIT SPECIES ...Anchovies, Captive Rearing, Commercial Fishing, Food Supply, Tuna, Mackerel, Albacore... , ...**5.0080**

DEVELOP FISHERIES FOR NON-TUNA RESOURCES ...Commercial Fishing, Fishing Gear, Pacific Ocean-general, Snappers, ...**5.0086**

INCREASE EFFICIENCY OF HAWAIIAN LONGLINE FISHERY ...Commercial Fishing, Fish & Shellfish, Fishing Gear, Production & Processing, Technique Development, Technological Development, ...**11.0022**

INVESTIGATE POPULATION DYNAMICS OF SKIPJACK TUNA IN HAWAIIAN WATERS ...Commercial Fishing, Economics, Environmental Ecology, Population Dynamics, Tuna, Mackerel, Albacore... , ...**5.0083**

SENSORY PROCESSES ...Basic Studies, Pathways, ...**5.0595**

Heat Transmission

Boiling & Evaporation

THERMALLY SUSTAINED PRESSURE OSCILLATIONS IN LIQUID HELIUM APPARATUS ...Boundary-layer-other, Conduction, Engineering Studies-general, Heat-transfer-other, Model Apparatus-other, Pressure Gradient, ...**8.0024**

Conduction

THERMAL PROPERTIES OF SEA WATER AT LOW TEMPERATURE AND HIGH PRESSURE ...Acoustical, Expansion, Hydrodynamics, Physical Analysis, Thermal, ...**1.0177**

THERMALLY SUSTAINED PRESSURE OSCILLATIONS IN LIQUID HELIUM APPARATUS ...Boiling & Evaporation, Boundary-layer-other, Engineering Studies-general, Heat-transfer-other, Model Apparatus-other, Pressure Gradient, ...**8.0024**

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INVESTIGATION OF HEAT TRANSFER AUGMENTATION THROUGH USE OF INTERNALLY FINNED TUBES ...Flexible, Heat Trans Coefficient, Heat Transfer, Rotating Fluids, ...**8.0189**

Heat Transfer

INVESTIGATION OF HEAT TRANSFER AUGMENTATION THROUGH USE OF INTERNALLY FINNED TUBES ...Convection, Flexible, Heat Trans Coefficient, Rotating Fluids, ...**8.0189**

HELIUM - HEAT TRANSFER ...Air, Diving and Scuba, Helium, Submersibles, Temperature Effects, ...**8.0201**

ADVANCES HEAT SOURCES AND THERMAL INSULATION MATERIALS FOR SWIMMER HEATING ...Diving and Scuba, Diving-system, Heating, Thermal, Thermal Insulators, ...**8.0021**

Radiation

REFLECTIVITY AND EMISSIVITY STANDARDS ...Atmosphere Radiation, Infrared Radiation, Interferometry, Radiation-general, Standards, Specifications, ...**4.0142**

Heavy Elements

MARINE GEOLOGY OF THE CALIFRONIA CONTINENTAL BORDERLAND WITH EMPHASIS ON FUTURE ECONOMIC DEVELOPMENT AND GENERAL RESOURCE VALUE ...California, Clay Minerals-general, Continental Shelf, Mineralogy, Ocean Mining, ...**7.0010**

MARINE HEAVY-METALS PRODUCTION INFORMATION, ON WORLDWIDE BASIS ...Appraisals-general, Beneficiation, Deposits-ores, Documents & Literature, Ocean Mining, ...**7.0006**

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OREGON-CALIFORNIA BLACK SANDS ...Beaches, California, Heavy Minerals, Mineralogy, Ocean Mining, Potential of Deposit, ...**7.0015**

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UNDERWATER WELDING ...Inert Gas, Materials Used Undersea, Safety, Scientific-service-support, Subsurface Environments, ...8.0344

HELIUM - HEAT TRANSFER ...Air, Diving and Scuba, Heat Transfer, Submersibles, Temperature Effects, ...8.0201

Histochemical Test

IMMUNE MECHANISMS AND RESISTANCE FACTORS IN MARINE FISHES ...Antigen, Fish -other, Serology and Immunology, ...5.0255

Home Economics

Consumer Pref. & Consumption

DETERMINATION OF THE STRUCTURE & ECONOMIC IMPORTANCE OF THE VARIOUS SEGMENTS OF THE SEAFOOD INDUSTRY ...Commercial Fishing, Fish & Shellfish, Fish -non-specific, Georgia, Production & Processing, Regional Economic Impact, Shellfish -non-specific, ...4.0180

REGIONAL DEMAND IN THE U.S. AND TRENDS IN THE FISHING AND SEAFOOD PROCESSING INDUSTRIES OF THE CHESAPEAKE BAY AREA ...Chesapeake Bay, Commercial Fishing, Consumption, Fish & Shellfish, Fish -non-specific, Market Structure, ...6.0028

ANALYZING THE FACTORS AFFECTING THE DEMAND FOR SEAFOOD AND TO PROJECT THIS DEMAND TO FUTURE TIME PERIODS ...Fish -non-specific, Food Needs and Demand, Trends,projections, ...6.0021

CONSUMER EVALUATION OF FISH PRODUCTS ...Fish & Shellfish, Fish -non-specific, Organoleptic Studies, Smoking, ...6.0004

ANALYSIS OF THE DEMAND FOR RED MEAT, POULTRY, EGGS, SEAFOOD, AND MEAT MIXTURES ...Eggs, Fish -non-specific, Meat -non-specific, Price & Value, ...6.0019

ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST ...Commercial Fishing, Fish -non-specific, Market Structure, Northeast, ...4.0183

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DEVELOPMENT OF RADIATION STERILIZED FISH ITEMS FOR ARMED FORCES FEEDING ...Anti-oxidants, Chemical Analysis, Fish -non-specific, Military Rations, Radiation, ...6.0073

Food Preparation

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ALGAL SUBSTANCES IN THE MARINE FOOD WEB ...Food Chains, Food Webs, Marine Plants, Phaeophyta (non-specific & Ot), Phenols, Secretions and Products, ...5.0725

Humidity Instruments

HUMIDITY STANDARDS AND MEASUREMENTS ...Evaporation, Humidity, Pressure-density, Standards, Specifications, Streams, ...8.0081

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CRITERIA FOR THE DESIGN OF SMALL CRAFT HARBORS ...Coastal Engineering-other, Harbors, Marinas, Seiches, Waves, ...8.0036

WAVE FORCES ON BREAKWATERS ...Hydrodynamics, Model Studies, Shoreline Structures, Wave Action, Waves, ...8.0044

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COASTAL WORKS EVALUATION FOR CHECKING, IMPROVING AND DEVELOPING DESIGN RELATIONSHIPS AND CONSTRUCTION TECHNIQUE ...Coastal Engineering-other, Design Criteria, Groin, Jetty, Shoreline Structures, ...8.0039

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KINEMATICS OF SEDIMENTS IN BREAKERS ...Development, Hydrodynamics, Sedimentation, Suspension, Waves, ...7.0237

FORCES AND MOTIONS INDUCED BY WAVES ON OCEAN PLATFORMS ...Models, Platforms, Wave Action, Waves, ...8.0312

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CIVIL ENGINEERING STRUCTURES IN THE OCEANS ...Engineering Studies-other, Foundations-general, Model Studies, Soil Dynamics, Waves, ...8.0340

GENERAL COASTAL INLET STUDIES ...Coastlines-shorelines, Discharge, Model Studies, Synthetic Hydrology, Tides, Water Motion, ...7.0125

COASTAL WORKS EVALUATION FOR CHECKING, IMPROVING AND DEVELOPING DESIGN RELATIONSHIPS AND CONSTRUCTION TECHNIQUE ...Breakwaters, Design Criteria, Groin, Jetty, Shoreline Structures, ...8.0039

METHODS OF BYPASSING SAND PAST INLETS ...By-passing, Ocean Waves - Currents, Shoreline Structures, Size, ...8.0040

DEVELOPMENT OF CRITERIA FOR ARTIFICIAL BEACHES ...Beach, Beaches, Design Criteria, Shoreline Structures, Statistics-general, ...8.0041

ECOLOGY OF WESTERN GULF ESTUARIES (ESTUARINE PROGRAM) ...Estuaries, Gulf of Mexico, Habitat Studies, Mans Activities, Pollution - Effects of , ...5.0928

Erosion Control

LOCALIZED SCOUR AROUND PILING SUBJECTED TO FIRST-ORDER STOKIAN WAVES ...Model Studies, Scouring, Water Tunnels Tables, Wave Action, Waves in Liquids, ...8.0043

Harbors

APPLIED MARINE ENGINEERING PROGRAM AT SCRIPPS INSTITUTION OF OCEANOGRAPHY ...California, Engineering Studies-general, Marine Biology, Marine Biology (nonspecific), Other-design-and-construction, Scientific-service-support, Teaching and Research, Training Grants, Fellowships, ...11.0006

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WAVE AND SURGE ACTION STUDY FOR LOS ANGELES-LONG BEACH HARBORS ...California, Models, Surface Ships, Wave Action, Waves, ...2.0098

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HARBOR DESIGN STUDIES ...Navigation, Waves, ...8.0046

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FORCES AND MOTIONS INDUCED BY WAVES ON OCEAN PLATFORMS ...Coastal Engineering-other, Platforms, Wave Action, Waves, ...8.0312

COMPUTER SIMULATION OF THE PROPAGATION OF SURFACE WAVES ...Channel Roughness, Partial, Velocity, Wave Motion in Fluids-other, Waves, ...4.0082

BARBERS POINT HARBOR MODEL STUDY ...Harbors, Hawaii, Model Studies, ...4.0104

WAVE AND SURGE ACTION STUDY FOR LOS ANGELES-LONG BEACH HARBORS ...California, Harbors, Surface Ships, Wave Action, Waves, ...2.0098

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KINEMATICS OF SEDIMENTS IN BREAKERS ...Coastal Engineering-other, Development, Hydrodynamics, Suspension, Waves, ...7.0237

SEDIMENT-FLUID INTERACTIONS ...Flow of Dispersed Solids, Geomorphology-topography, Textures-structures, Wave Action, Waves-internal, ...7.0245

EXPERIMENTAL AND THEORETICAL RESEARCH ON TURBIDITY CURRENTS ...Currents-other, Hydraulic Structures, Laboratory Analysis, ...7.0243

External Pressure on Structure

Ext Pressure on Struct-general

WAVE FORCES ON BREAKWATERS ...Breakwaters , Shoreline Structures, Wave Action, Waves, ...8.0234

Floating Structure Stability

STABLE OCEANIC STATION ...Engineering Studies-other, Platforms, Underwater-construction, ...8.0287

Fluid Flow

Channel Roughness

AN ANALYTICAL AND EXPERIMENTAL STUDY OF BED FORMS UNDER WATER WAVES ...Friction, Geomorphology-topography, Model Studies, Water Tunnels Tables, Wave Action, Waves, ...2.0110

COMPUTER SIMULATION OF THE PROPAGATION OF SURFACE WAVES ...Models, Partial, Velocity, Wave Motion in Fluids-other, Waves, ...4.0082

Flume

EFFECTS OF SCALE AND OPERATING TECHNIQUE ON HARBOR MODELS ...Harbors, Synthetic Hydrology, ...4.0074

Friction

AN ANALYTICAL AND EXPERIMENTAL STUDY OF BED FORMS UNDER WATER WAVES ...Channel Roughness, Geomorphology-topography, Model Studies, Water Tunnels Tables, Wave Action, Waves, ...2.0110

EFFECTS OF SCALE AND OPERATING TECHNIQUE ON HARBOR MODELS ...Harbors, Synthetic Hydrology, ...4.0074

Wave Action

WAVE DAMPING SYSTEMS ...Breakwaters, Energy Dissipators, Model Studies, Shoreline Structures, Waves, ...8.0047

WAVE UPLIFT FORCES ON HORIZONTAL PLATFORMS ...Hydrodynamic Structures, Platforms, Waves, ...8.0266

FORCES AND MOTIONS INDUCED BY WAVES ON OCEAN PLATFORMS ...Coastal Engineering-other, Models, Platforms, Waves, ...8.0312

SEDIMENT-FLUID INTERACTIONS ...Flow of Dispersed Solids, Geomorphology-topography, Sedimentation, Textures-structures, Waves-internal, ...7.0245

LOCALIZED SCOUR AROUND PILING SUBJECTED TO FIRST-ORDER STOKIAN WAVES ...Erosion Control, Model Studies, Scouring, Water Tunnels Tables, Waves in Liquids, ...8.0043

AN ANALYTICAL AND EXPERIMENTAL STUDY OF BED FORMS UNDER WATER WAVES ...Channel Roughness, Friction, Geomorphology-topography, Model Studies, Water Tunnels Tables, Waves, ...2.0110

WAVE AND SURGE ACTION STUDY FOR LOS ANGELES-LONG BEACH HARBORS ...California, Harbors, Models, Surface Ships, Waves, ...2.0098

WAVE FORCES ON BREAKWATERS ...Breakwaters, Hydrodynamics, Model Studies, Shoreline Structures, Waves, ...8.0044

WAVE FORCES ON BREAKWATERS ...Breakwaters, Ext Pressure on Struct-general, Shoreline Structures, Waves, ...8.0234

STABILITY OF RUBBLE-MOUND BREAKWATERS ...Breakwaters, Design Criteria, Engineering Structures-general, Hydrodynamics, Shoreline Structures, Waves, ...8.0045

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WAVE ACTION ON STRUCTURES ...Engineering Structures-general, Hydrodynamic Structures, Models, Shoreline Structures, Stability, Waves, ...8.0175

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LITERATURE SEARCH AND PRELIMINARY ENGINEERING STUDIES OF ENVIRONMENTAL PROBLEMS ASSOCIATED WITH MARINE DEPOSIT DELINEATION TECHNIQUES ...Currents-ocean, Drilling Operation, Oil and Natural Gas - Sulfur, Survey Studies, ...8.0251

Hydraulic Engineering-other

HYDRAULIC BULLETIN ...Current Research Projects, Hydraulics-general, Tables, Compilations, Catalogs, ...8.0177

Water Control Works

Design Criteria

STABILITY OF RUBBLE-MOUND BREAKWATERS ...Breakwaters, Engineering Structures-general, Hydrodynamics, Shoreline Structures, Wave Action, Waves, ...8.0045

HARBOR DESIGN STUDIES ...Harbors, Navigation, Waves, ...8.0046

COASTAL WORKS EVALUATION FOR CHECKING, IMPROVING AND DEVELOPING DESIGN RELATIONSHIPS AND CONSTRUCTION TECHNIQUE ...Breakwaters, Coastal Engineering-other, Groin, Jetty, Shoreline Structures, ...8.0039

DEVELOPMENT OF CRITERIA FOR ARTIFICIAL BEACHES ...Beach, Beaches, Coastal Engineering-other, Shoreline Structures, Statistics-general, ...8.0041

Groin

ANALYSIS OF AN ATTEMPT TO CONTROL BEACH EROSION AT SCIENTISTS CLIFFS, MARYLAND ...Beaches, Chesapeake Bay, Engineering Studies-other, Erosion, Maryland, ...8.0038

COASTAL WORKS EVALUATION FOR CHECKING, IMPROVING AND DEVELOPING DESIGN RELATIONSHIPS AND CONSTRUCTION TECHNIQUE ...Breakwaters, Coastal Engineering-other, Design Criteria, Jetty, Shoreline Structures, ...8.0039

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COASTAL WORKS EVALUATION FOR CHECKING, IMPROVING AND DEVELOPING DESIGN RELATIONSHIPS AND CONSTRUCTION TECHNIQUE ...Breakwaters, Coastal Engineering-other, Design Criteria, Groin, Shoreline Structures, ...8.0039

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Hydraulics-general

APOLLO TEST SITE EXPERIMENT ...Aircraft, Estuaries, Hydrology-general, Recognition Systems, Remote Sensing-general, ...4.0146

DYNAMIC MODEL STUDY OF LAKE ERIE ...Inflow, Lake Erie, Model Studies, Synthetic Hydrology, ...4.0075

HYDRAULIC BULLETIN ...Current Research Projects, Hydraulic Engineering-other, Tables, Compilations, Catalogs, ...8.0177

TIDAL FLOWS IN RIVERS AND HARBORS ...Committee-support, Harbors, Streams, Tides, ...2.0087

Hydrazine

ENERGY CONVERSION MATERIALS AND COMPONENTS ...Durability, Deterioration, Electrode, Fuel Cell-other, Hydrocarbon, Pressure, ...8.0223

Hydrodynamics

OCEANOGRAPHIC DATA SYSTEMS ...Acoustical, Data & Statistics Storage, Engineering Studies-other, Instrumentation-general, Pollution Sources-general, ...4.0013

WATER PHYSICS AND CHEMISTRY ...Chemical-general, Infrared Radiation, Lasers-masers, Satellites, Thermal Pollution, ...4.0147

GULF STREAM EDDIES ...Data Analysis - General, Data Reduction and Analysis, Gulf Stream, Temperature, Water Motion, ...2.0028

KINEMATICS OF SEDIMENTS IN BREAKERS ...Coastal Engineering-other, Development, Sedimentation, Suspension, Waves, ...7.0237

LONG PERIOD WAVES ...Fjords, Iceland, Seiches, Tides, Waves, ...2.0108

HAWAIIAN OCEANOGRAPHY ...Circulation-general, Environmental Effects-geologic, Hawaii, Islands, Ocean Currents-other, ...2.0021

OCEAN CIRCULATION STUDIES ...Acoustical, Atlantic Ocean-north, Currents-ocean, Statistics-general, Water Motion Recorders, Waves-internal, ...2.0040

CIRCULATION STUDIES ...Circulation-general, Currents-ocean, Gulf of Mexico, Mixing, Pacific Ocean-east, ...2.0042

HIGH FREQUENCY WAVES ...Forecasting-prediction, Heat and Radiation Transfer, Water Motion Recorders, Waves, ...2.0113

INERTIAL TECHNIQUES ...Acoustical, Currents-ocean, Physical Analysis, ...8.0099

VERTICAL MOTIONS ...Convection, Gulf Stream, Water Motion Recorders, ...2.0060

NORTH ATLANTIC CIRCULATION ...Atlantic Ocean-north, Circulation-general, Geomorphology-topography, Gulf Stream, Oceanic Fronts, ...2.0031

STUDY OF OCEANIC TURBULENCE ...Energy, Mixing, Subsurface Environments, Turbulence - Sea Water, Water Motion, ...2.0055

FORMATION OF ANTARCTIC BOTTOM WATERS ...Buoys, Oceanic Fronts, Salinity, Temperature, Weddell Sea, ...1.0152

EXPERIMENTAL STUDY OF THE INTERRELATIONS BETWEEN WIND-WAVE PROPERTIES ...Mixing, Pressure, Turbulence - Sea Water, Waves, Wind-water Interaction, ...2.0123

GULF STREAM TRANSPORT ...Automatic Stations, Gulf Stream, Ships and Cruises, Water Motion Recorders, ...2.0029

STUDY OF INFLUENCE OF STRATIFICATION ON CURRENT STRUCTURE ...Circulation-general, Currents-other, Lake Michigan, Stratified Flow, ...2.0035

PHYSICAL OCEANOGRPAHY IN OREGON SHELF AND SLOPE WATERS ...Continental Shelf, Continental Slope, Mixing, Oregon, Thermodynamics, ...2.0076

EXPERIMENTAL HYDRODYNAMICS ...Fluid Dynamics, Heat and Radiation Transfer, Simulation Theory, Submersibles, Thermocline, ...8.0192

FIORD OCEANOGRAPHY ...Alaska, Estuaries, Fjords, Model Studies, Simulation Theory, ...4.0040

THERMAL PROPERTIES OF SEA WATER AT LOW TEMPERATURE AND HIGH PRESSURE ...Acoustical, Conduction, Expansion, Physical Analysis, Thermal, ...1.0177

OCEAN CIRCULATION ...California Current, Circulation-general, Forecasting-prediction, Model Studies, Submarine Canyons, ...2.0002

WAVE FORCES ON BREAKWATERS ...Breakwaters, Model Studies, Shoreline Structures, Wave Action, Waves, ...8.0044

FLUID MECHANICS RESEARCH ...Forecasting-prediction, Industrial Engineering, Ship Resistance Stability, Waves, ...8.0176

FUNDAMENTAL PROBLEMS IN HYDRODYNAMICS ...Convection, Ordnance, Survey Studies, Waves, Waves-internal, ...2.0102

SEA-AIR INTERACTION RESEARCH ...Acoustical, Heat and Radiation Transfer, Salinity, Waves, ...3.0039

OCEAN DYNAMICS SEA AIR INTERACTION MODELS-MEDITERRANEAN ...Acoustical, Mediterranean Sea-general, Model Studies, Surface Environments, Wind-water Interaction, ...3.0002

OCEAN DYNAMICS IN THE STRAITS OF GIBRALTAR AND ADJACENT AREAS ...Acoustical, Anti-submarine-warfare, Computer Applications, Model Studies, Strait of Gibraltar, Submerged Ships, ...1.0141

OCEAN DYNAMICS - OCEANOGRAPHIC ANALYSES AND FORECASTING MODELS ...Acoustical, Air-sea Boundary-general, Model Studies, Surface Environments, Temperature, ...1.0004

OCEANOGRAPHIC RESEARCH ...Acoustical, Instrumentation-general, Moorings, Naval Architecture-general, Water Motion Recorders, ...1.0052

SHALLOW WATER OCEANOGRAPHY ...Acoustical, Continental Shelf, Rhode Island, Surface Environments, Transmission, ...1.0030

PREDICTION OF POLAR ICE BEHAVIOR AND DISTRIBUTION ...Arctic Ocean, Data Acquisition, Forecasting-prediction, Ice-general, Sea Ice, Weather Forecasting, ...3.0078

STABILITY OF RUBBLE-MOUND BREAKWATERS ...Breakwaters, Design Criteria, Engineering Structures-general, Shoreline Structures, Wave Action, Waves, ...8.0045

Hydrogen

HYDROGEN PROPERTIES ...Density, Dielectric Properties, Fuel Cell-other, Marine Propulsion, Refraction, ...8.0157

RESEARCH AND COMPUTATIONS ON THE THERMODYNAMIC PROPERTIES OF AIR AND RELATED GASES ...Air, Critical, Free Energy, Virial Coefficient, ...3.0014

Hydrology-general

APOLLO TEST SITE EXPERIMENT ...Aircraft, Estuaries, Hydraulics-general, Recognition Systems, Remote Sensing-general, ...4.0146

SIMULATION MODELS OF SHALLOW-WATER AND COASTAL ENVIRONMENTS ...Computer Applications, Gulf of Mexico, Model Studies, Sedimentation, Shoreline - Coastline, ...4.0066

HYDROLOGY OF UPPER OLD TAMPA BAY, FLORIDA ...Bays, Groundwater Movement, Lakes, Permeability, Water Harvesting, Water Quality-general, ...2.0067

Hypophysectomy

ENDOCRINE REGULATED PROCESSES IN TELEOST FISHES ...Comparative Physiology, Environment Resistance, Fish - other, Osmoregulation, Pituitary, ...5.0288

Hypoxanthine

BIOCHEMISTRY OF FISH AS RELATED TO HUMAN NUTRITION ...Amino Acids, Northeast, ...6.0053

Ice Studies

Alteration

SPECIALIZED RESEARCH EQUIPMENT FOR SEA ICE STUDIES ...Equipment Purchase Operation, Sea Ice, ...3.0086

GREAT LAKES RESEARCH - ICE COVER DISTRIBUTION ...Aerial Photography, Aerospatial, Great Lakes-general, Petrofabrics, Sea Ice, ...3.0083

GREAT LAKES RESEARCH - GREAT LAKES DEICING ...Bibliography, Great Lakes-general, Ice Properties-general, Origin, Sea Ice, ...3.0084

Composition

CARBON MONOXIDE CONTENT OF GLACIAL ICE AND THE NATURAL ATMOSPHERE ...Carbon, Dispersion - Transporation, Gases, Mono-oxide, ...3.0068

Ice Jam

GREAT LAKES RESEARCH - RIVER ICE JAMS ...Great Lakes-general, Streams, Survey Studies, Water Motion, ...3.0081

Ice-general

ENVIRONMENTAL APPLICATIONS OF PASSIVE MICROWAVE SENSORS ...Beaches, Microwave Radiation, Sea Ice, Sedimentology-general, Snow-general, Soil Engineering Investigation, ...4.0136

PREDICTION OF POLAR ICE BEHAVIOR AND DISTRIBUTION ...Arctic Ocean, Data Acquisition, Forecasting-prediction, Hydrodynamics, Sea Ice, Weather Forecasting, ...3.0078

Origin

GREAT LAKES RESEARCH - ICE CHARACTERISTICS ...Aerial Photography, Lake Superior, Micrometeorology, Petrofabrics, Radiation-terrestrial, Sea Ice, ...3.0082

GREAT LAKES RESEARCH - GREAT LAKES DEICING ...Alteration, Bibliography, Great Lakes-general, Ice Properties-general, Sea Ice, ...3.0084

Petrofabrics

GREAT LAKES RESEARCH - ICE CHARACTERISTICS ...Aerial Photography, Lake Superior, Micrometeorology, Origin, Radiation-terrestrial, Sea Ice, ...3.0082

GREAT LAKES RESEARCH - ICE COVER DISTRIBUTION ...Aerial Photography, Aerospatial, Alteration, Great Lakes-general, Sea Ice, ...3.0083

Properties

Electrical

ELECTRICAL PROPERTIES OF ICE ...Audio Frequency, Phase Relationships, Sea Ice, ...3.0072

Ice Acoustics

HF AUDIO ABSORPTION IN ICE ...Acoustical, Attenuation, Reverberation, Salinity, Sea Ice, ...3.0073

ARCTIC SEISMIC TRANSDUCER EVALUATION ...Applied Electronics, Arctic, Evaluation Other, Propagation, Transducers, ...8.0118

ARCTIC ACOUSTIC RESEARCH ...Applied Electronics, Arctic, Noise, Transmission, ...1.0001

ARCTIC AND COLD WEATHER SUPPORTING TECHNOLOGY ...Acoustical, Pressure, Sea Ice, Transmission, ...3.0079

Ice Properties-general

ARCTIC ADVISORY SERVICE ...Arctic Ocean, Bibliography, Library, Sea Ice, ...11.0012

ARCTIC UNDERSEAS RESEARCH, PHYSICAL AND CHEMICAL PROPERTIES OF SEA ICE ...Arctic Ocean, Environmental Effects-geologic, Model Studies, Sea Ice, ...3.0070

GREAT LAKES RESEARCH - GREAT LAKES DEICING ...Alteration, Bibliography, Great Lakes-general, Origin, Sea Ice, ...3.0084

Icebergs

ICEBERG DRIFT AND DETERIORATION ...Circulation-general, Model Studies, Ocean Currents-other, ...3.0076

OCEANOGRAPHY OF THE GRAND BANKS AND LABRADOR SEA ...Buoys, Circulation-general, Labrador Current, Labrador Sea, Meteorological Studies, ...4.0124

WEST GREENLAND GLACIER SURVEY ...Glacial Environment, Greenland, Movement, Photography, Types, ...3.0077

Iceland

BIOLOGICAL RESEARCH ON THE VOLCANIC ISLAND SURTSEY AND ENVIRON ...Migration, Volcanoes, ...5.0889

SYSTEMATICS, MORPHOLOGY, AND ECOLOGICAL DISTRIBUTION OF ALGO AND WOOD-INHABITING MARINE AND FRESHWATER FUNGI OF SURTSEY AND ICELAND ...Aquatic Fungi (non-specific), Islands, Marine Fungi (non-specific), Plant Taxonomy, Range Or Territorial Distr. , ...5.0714

LONG PERIOD WAVES ...Fjords, Hydrodynamics, Seiches, Tides, Waves, ...2.0108

BIOLOGICAL COLONIZATION OF A RECENTLY FORMED ISLAND ...Habitat Studies, Islands, Productivity - Food Chain, Succession, Volcanoes, ...5.0925

ECOLOGICAL SUCCESSION ON SURTSEY ...Fouling, Plant Succession, Succession, Volcanoes, ...5.0890

Immunity

ANTIGEN DISTRIBUTION OF DEVELOPING SEA URCHIN EMBRYOS ...Antigen, Basic Embryology, Interspecific Genetic Relat. , RNA , Sea Urchins & Other Echinoderm, ...5.0585

Antibody Formation

USEFUL BIOMEDICAL MATERIALS DERIVED FROM THE SEA - AN INTERDISCIPLINARY APPROACH ...Bioluminescence, Immunology, Molec. struct. (gen. & Other), ...6.0106

Immunology Methods

PROVIDE FOR ACTIVITIES OF TUNA BLOOD GROUP CENTER ...Blood Plasma and Serum, Blood Typing Studies, Hawaii, Tuna, Mackerel, Albacore... , ...5.0258

Indian Ocean-general

SUBMARINE SEISMIC PROFILES OF THE WORLDS OCEANS ...Atlantic Ocean-general, Cables and Transmission Lines, Data Analysis - General, Seismic Studies, Subbottom, ...7.0150

STRUCTURE OF OCEAN BASINS ...Basins, Bathymetry, Charts, Ridges, Structural Studies, ...7.0092

PARASITIC COPEPODA %CRUSTACEA*ROM INVERTEBRATES AND FISHES ...Animal Taxonomy, Copepods, Ectoparasites, Invertebrate Anatomy, ...5.0451*

RESEARCH ON INDO-WEST PACIFIC MARINE MOLLUSKS OF THE FAMILY CONIDAE ...Animal Taxonomy, Gastropods -slugs,conch,snails, Invertebrate Anatomy, Number Or Density, ...5.0517

COPEPOD CRUSTACEANS PARASITIC ON FISHES ...Collections, Copepods, Ectoparasites, Fish -non-specific, Ships and Cruises, Vertical Distribution, ...5.0368

TAXONOMY OF CALCAREOUS GREEN ALGAE ...Chlorophyceae (non-specif.&ot), Plant Morphology, Plant Taxonomy, Range Or Territorial Distr. , Reproductive Physiology, ...**5.0718**

MARINE PHYTOPLANKTON RESEARCH ...Algal Culture, Nutrition Studies, Pacific Ocean-general, Phytoplankton, Symbiosis, ...**5.0847**

INTERNATIONAL INDIAN CEAN EXPEDITION PHYSICAL AND CHEMICAL ATLAS ...Data & Statistics Storage, Data Analysis - General, General Sea Water Chemistry, Tables, Compilations, Catalogs, Water Properties-general, ...**4.0130**

ANALYSIS OF SEISMIC DATA COLLECTED DURING THE INTERNATIONAL INDIAN OCEAN EXPEDITION AND IN THE CARIBBEAN SEA ...Basins, Data Analysis - General, Ridges, Seismic Reflection, Textures-structures, ...**7.0119**

GRAVITY AND MAGNETIC DATA COLLECTED DURING THE INTERNATIONAL INDIAN OCEAN EXPEDITION AND IN THE CARIBBEAN SEA ...Data Analysis - General, Data Reduction and Analysis, Digital Computer Applications, Gravity Studies, Magnetic Studies, Research - Development, ...**4.0030**

ANALYSES OF ROCKS COLLECTED IN THE INDIAN AND ATLANTIC OCEANS ...Atlantic Ocean-general, Crust, Ocean Basins, Petrology, Structural Studies, ...**7.0073**

INDIAN OCEAN FORAMINFERA AND SEDIMENTS ...Biofacies, Geographical Relations, Order Foraminifera, Pacific Ocean-south, Sedimentology-general, ...**7.0195**

STUDIES IN THE INDIAN OCEAN ...Circulation-general, Data Analysis - General, Particle-gas Transfer, Storms-general, ...**2.0073**

PHYSICAL AND CHEMICAL ATLAS ...Atlases-maps, Convection, General Sea Water Chemistry, Water Analysis-general, Water Properties-general, ...**4.0026**

INTERACTIONS BETWEEN TURBULENCE, CLOUDS, SEA TEMPERATURE ...Data Analysis - General, Line Islands, Patterns, Temperature, Turbulence, ...**3.0025**

DISTRIBUTION OF CARBON AND RADIUM IN THE ANTARCTIC WATERS ...Carbon, Gases, Radium, Sampling, Trace Elements, ...**1.0109**

INDIAN OCEAN DATA REDUCTION ...Bathymetry, Data Analysis - General, Geophysics-general, Ocean Basins, Sedimentology-general, ...**4.0034**

BIO-ACOUSTIC AND BIOLOGICAL SAMPLING GEAR STUDIES ...Acoustical, Mapping, Organism Sampling Devices, Plankton (non-specific), ...**8.0126**

TAXONOMY AND DISTRIBUTION OF CLUPEOIDS AND REVISION OF THE GENUS ILISHA OF THE FAMILY CLUPEIDAE ...Alewife,menhaden,shad,herring, Animal Taxonomy, Handbooks, Nomenclature, Classification, Range Or Territorial Distr. , ...**5.0088**

SYSTEMATICS AND BIOLOGY OF EPIPELAGIC AND BATHYPELAGIC FISHES ...Animal Taxonomy, Atlantic Ocean-north, Fish -other, Vertebrate Anatomy, Vertical Distribution, ...**5.0049**

OSTRACODA OF THE INDIAN OCEAN ...Animal Taxonomy, Biogenous, Quaternary Period, Shrimps - Seed Or Mussel, ...**5.0385**

SYSTEMATIC STUDIES ON MOLLUSKS FROM WALTERS SHOALS, INDIAN OCEAN ...Animal Taxonomy, Collections, Ethiopian, Mollusks -non-specific & Other, ...**5.0402**

SYSTEMATICS AND MORPHOLOGY OF THE SIPUNCULID LARVAE OF THE INDIAN OCEAN ...Animal Taxonomy, Developmental Physiology, Invertebrate Anatomy, Invertebrates -non-specific, ...**5.0765**

SYSTEMATIC STUDY OF MYODOCOPID OSTRACODS OF THE INDIAN OCEAN ...Animal Taxonomy, Collections, Expeditions, Shrimps - Seed Or Mussel, ...**5.0394**

SYSTEMATIC REVISION PLATYCEPHALIDAE (PISCES) ...Classical, Fish -other, Museum, Nomenclature, Classification, ...**5.0050**

SYSTEMATIC STUDIES ON THE FAMILY SCOMBRIDAE ...Animal Taxonomy, Nomenclature, Classification, Tuna, Mackerel, Albacore... , Vertebrate Anatomy, ...**5.0056**

Industrial Engineering

FLUID MECHANICS RESEARCH ...Forecasting-prediction, Hydrodynamics, Ship Resistance Stability, Waves, ...**8.0176**

Industrial Operation

PROCESS ENGINEERING ...Design, Machinery, Equipment, Esters, Extraction, Fats and Oils -other, Fish Protein Concentrate, Legal Standards, Natural Occurring, ...**6.0080**

Industrial Wastes

Desalination Wastes

BRACKISH WATER PURIFICATION BY BIOLOGICAL FUEL CELL POWERED ELECTRODIALYSIS ...Biological, Brackish Water, Desalination, Electrodialysis, Material Recovery Wastes, Water Costs, ...**6.0161**

Material Recovery Wastes

BRACKISH WATER PURIFICATION BY BIOLOGICAL FUEL CELL POWERED ELECTRODIALYSIS ...Biological, Brackish Water, Desalination, Desalination Wastes, Electrodialysis, Water Costs, ...**6.0161**

MODEL ADVANCED WASTE-TREATMENT PLANT ...Activated Carbon, Lime Treatment, Pilot Plant, Process Design, Solid Waste, ...**8.0326**

Pulp and Paper Wastes

COASTAL DIFFUSION OF POLLUTANTS ...Currents-other, Model Studies, Ocean, Oregon, Outlet, ...**6.0174**

Industries

Atomic Plants

MILLSTONE POINT TEMPERATURE SURVEY ...Connecticut, Electric Power Plants, Salinity, Temperature, ...**1.0181**

Electric Power Plants

MILLSTONE POINT TEMPERATURE SURVEY ...Atomic Plants, Connecticut, Salinity, Temperature, ...**1.0181**

CALORIC - AN INVESTIGATION OF HEAT RELEASE PATTERNS ASSOCIATED WITH PRESENT AND PLANNED LAKESHORE ELECTRICAL POWER PLANTS ...Lake Erie, Model Studies, Nuclear Power, Pollution - Effects of , Temperature, Thermal Pollution, ...**1.0186**

INSTRUEMTATION FOR LAKE CAYUGA HEAT RELEASE STUDY ...Heat Flow, Lakes, New York, Temperature, Thermal Pollution, ...**8.0105**

AN ECOLOGICAL STUDY OF SOUTH BISCAYNE BAY IN THE VICINITY OF TURKEY POINT ...Applied Ecology, Balance of Nature, Bays, Environmental Ecology, Florida, Phytoplankton, Thermal Pollution, ...**5.0877**

MONTVILLE STATION TEMPERATURE SURVEY (THAMES RIVER) ...British Isles, Estuaries, Maps-other, Temperature, Thermal Pollution, ...**1.0182**

A UNIFIED APPROACH TO WATER, FOOD AND POWER IN A COASTAL DESERT COMMUNITY ...Arid and Desert, Desalination, Deserts, Diesel, Distilling Units, Greenhouse, Use of Impaired Water, ...**7.0002**

EFFECTS OF HEATED WATER IN A TIDAL ESTUARY ...Chesapeake Bay, Pollution - Effects of , Pollution Effects, Thermal Pollution, Tidal Streams, Water Properties-general, ...**6.0145**

COLLECTION OF JUVENILE MIGRANTS FROM RIVERS AND STREAMS ...Engineering Structures-general, Fish -non-specific, Management -other, Migration, Streams, ...**5.0513**

Food Processing Industry

A PROGRAM FOR THE TRAINING OF STAFF MEMBERS FROM THE SCHOOL OF FISHERIES OF THE CATHOLIC UNIVERSITY OF VALPARAISO CHILE ...Chile, Fish -non-specific, Marine Biology, Teaching and Research, ...**5.0181**

Industrial-general

FLUSHING PATTERN OF CERTAIN TIDAL STREAMS IN DELAWARE ...Aquatic Ecology, Circulation -water, Delaware, Discharge, Tidal Streams, ...**2.0013**

SALT-WATER ENCROACHMENT IN NORTH CAROLINA ESTUARIES ...Chemical-general, Estuaries, Flow Characteristics -water, Saline Water Intrusion, Sampling, ...**6.0168**

Industries

Pulp, Paper , and Logging

ECOLOGICAL SURVEY OF EFFLUENT DISCHARGE AT TWO PULP MILLS IN HUMBOLDT COUNTY, CALIFORNIA ...California, Chemical Analysis (water), Effluents-waste Water, Pollution - Effects of , Pollution Effects, ...5.0858

MONITORING THE EFFECTS OF LAND USE ON SALMON PRODUCTION ...Alaska, Environmental Ecology, Land Use, Salmon & Trout - Non-specific, Streams, ...5.0192

EFFECTS OF LOG RAFTING ON DUNGENESS CRAB ...Contamination - Water, Crabs, Diving and Scuba, Forestry, Mans Activities, ...5.0347

ESTUARINE WATER QUALITY AND FISH DISTRIBUTION ...Contamination - Water, Environmental Physiology, Estuaries, Pollution Effects, Salmon & Trout - Non-specific, ...5.0178

ECOLOGY OF KRAFT PAPER MILL EFFLUENT IN SAPELO & ST. CATHERINES SOUNDS, GA ...Aquatic Ecology, Georgia, Pollution - Effects of , Pollution Effects, Streams, ...5.0886

EFFECTS OF KRAFT PULP MILL EFFLUENTS ON THE GROWTH AND PRODUCTION OF FISH ...Contamination - Water, Industrial Wastes, Pollution - Effects of , Pollution Effects, Population Dynamics, Salmon & Trout - Non-specific, ...5.0311

RELATIONSHIP BETWEEN GLACIAL FLOUR POLLUTION AND POLLUTANTS FROM OTHER SOURCES ...Adsorption, Adsorption Capacity, Alaska, Estuaries, Glacial Clastics, Pollution - Effects of , Size, ...6.0134

Inflow

HYDROLOGIC SYSTEMS ANALYSIS OF THE GREAT LAKES ...Discharge, Great Lakes-general, Water Storage, ...4.0076

DYNAMIC MODEL STUDY OF LAKE ERIE ...Hydraulics-general, Lake Erie, Model Studies, Synthetic Hydrology, ...4.0075

FLOW AND SALINITY IN THE HUDSON ESTUARY, NEW YORK ...Estuaries, Fresh Water, Management, Salinity, Tides, ...2.0075

Information Centers & Services

Critically Evaluated Data

BATHYTHERMOGRAPH ANALYSIS ...Bathythermographs , Data Analysis - General, Model Studies, Salinity, Surface Environments, Temperature, ...1.0178

Current Research Projects

HYDRAULIC BULLETIN ...Hydraulic Engineering-other, Hydraulics-general, Tables, Compilations, Catalogs, ...8.0177

Data & Statistics Storage

OCEANOGRAPHIC DATA SYSTEMS ...Acoustical, Engineering Studies-other, Hydrodynamics, Instrumentation-general, Pollution Sources-general, ...4.0013

SUPPORT OF THE NATIONAL OCEANOGRAPHIC DATA CENTER ...Documents & Literature, Oceanography-general, ...12.0017

INTERNATIONAL INDIAN CEAN EXPEDITION PHYSICAL AND CHEMICAL ATLAS ...Data Analysis - General, General Sea Water Chemistry, Indian Ocean-general, Tables, Compilations, Catalogs, Water Properties-general, ...4.0130

SUPPORT OF WORLD DATA CENTER - A (OCEANOGRAPHY) ...Data Reduction and Analysis, Facilities, Oceanography-general, Writing & Editing, ...12.0018

SUPPORT OF THE NATIONAL OCEANOGRAPHIC DATA CENTER ...Oceanography-general, ...12.0016

USES OF STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN FOR EFFICIENT COLLECTION OF OCEAN DATA ...Information Retrieval Methods, Sampling, ...4.0015

FOSDIC APPLICATION TO CURRENT-METER RECORDS ...Currents-ocean, Recording Systems, Research - Development, Technique Development, Water Motion Recorders, ...4.0021

OCEANOGRAPHIC INFORMATION PROCESSING TECHNOLOGY ...Computer Applications, Data Reduction and Analysis, Information Retrieval Methods, Information Storage and File, Oceanography-general, Real Time Systems, ...4.0023

Documents & Literature

SUPPORT OF THE NATIONAL OCEANOGRAPHIC DATA CENTER ...Data & Statistics Storage, Oceanography-general, ...12.0017

MARINE HEAVY-METALS PRODUCTION INFORMATION, ON WORLDWIDE BASIS ...Appraisals-general, Beneficiation, Deposits-ores, Heavy Elements, Ocean Mining, ...7.0006

General Information Services

COASTAL MORPHOLOGY ...Beach, Deltas, Development, Shore Features-general, Shoreline - Coastline, Tropic, ...7.0297

WOODS HOLE STUDY ACTIVITIES ...Acoustical, Consultants, Advisory Services, Engineering Studies-general, ...11.0031

TECHNICAL ASSISTANCE TO INDUSTRY ...Alaska, Commercial Fishing, Diffusion of Information, Fishing Gear, ...5.0031

Library

ARCTIC ADVISORY SERVICE ...Arctic Ocean, Bibliography, Ice Properties-general, Sea Ice, ...11.0012

SURVEY, EVALUATION & SUMMARIZATION OF LITERATURE ON ENVIRONMENTAL REQUIREMENTS OF MARINE ORGANISMS LEVELS OF POTENTIAL TOXICANTS (ABBREV ...Biology, Chemical, Environmental Effects-geologic, Geosciences, Marine Biology, Marine Environments-general, Survey Studies, ...4.0037

Information Systems

Bioscience Applications

Biology

SURVEY, EVALUATION & SUMMARIZATION OF LITERATURE ON ENVIRONMENTAL REQUIREMENTS OF MARINE ORGANISMS LEVELS OF POTENTIAL TOXICANTS (ABBREV ...Chemical, Environmental Effects-geologic, Geosciences, Library, Marine Biology, Marine Environments-general, Survey Studies, ...4.0037

Information Retrieval Methods

USES OF STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN FOR EFFICIENT COLLECTION OF OCEAN DATA ...Data & Statistics Storage, Sampling, ...4.0015

OCEANOGRAPHIC INFORMATION PROCESSING TECHNOLOGY ...Computer Applications, Data & Statistics Storage, Data Reduction and Analysis, Information Storage and File, Oceanography-general, Real Time Systems, ...4.0023

Information Storage and File

OCEANOGRAPHIC INFORMATION PROCESSING TECHNOLOGY ...Computer Applications, Data & Statistics Storage, Data Reduction and Analysis, Information Retrieval Methods, Oceanography-general, Real Time Systems, ...4.0023

Physical Sciences Applications

Geosciences

SURVEY, EVALUATION & SUMMARIZATION OF LITERATURE ON ENVIRONMENTAL REQUIREMENTS OF MARINE ORGANISMS LEVELS OF POTENTIAL TOXICANTS (ABBREV ...Biology , Chemical, Environmental Effects-geologic, Library, Marine Biology, Marine Environments-general, Survey Studies, ...4.0037

Tape Storage

A SHIPBOARD DIGITAL DATA ACQUISITION SYSTEM ...Data Acquisition, Seismic Studies, Systems Analysis, ...4.0036

Writing & Editing

SUPPORT OF WORLD DATA CENTER - A (OCEANOGRAPHY) ...Data & Statistics Storage, Data Reduction and Analysis, Facilities, Oceanography-general, ...12.0018

Insects

Aedes Mosquitoes

THE EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ON BEEF CATTLE PRODUCTION, PLANT ECOLOGY, SOIL PRODUCTIVITY, AND ESTUARINE ANIMALS ...Cultural Control of Insects, Ectoparasitic Insects, Management, Wetlands, ...5.0927

Giant Water Bug, Water Strider

NEUROPHYSIOLOGICAL MECHANISMS IN BEHAVIOR ...Horseshoe Or King Crabs, Locomotion, Proprioceptors, ...**5.0490**

Katydids

CONDUCTION AND INTEGRATION ...Behavior, Cellular Physiology, Hydra, Portuguese Man-of-war, Musculoskeletal System, Nervous System, ...**5.1018**

Inspection and Control

Flaw Detection

Flaw Detection - Other

STRUCTURAL DESIGN CRITERIA ...Hull, Hydrodynamic Structures, Process Control, Safety, Stress Concentration-toughness, ...**8.0283**

METAL ANALYSIS/TEST INSPECTION ...Hull, Materials Used Undersea, Penetrating Ray, Standards, Specifications, Ultrasonic and Sonic, ...**8.0218**

Penetrating Ray

METAL ANALYSIS/TEST INSPECTION ...Flaw Detection - Other, Hull, Materials Used Undersea, Standards, Specifications, Ultrasonic and Sonic, ...**8.0218**

Ultrasonic and Sonic

METAL ANALYSIS/TEST INSPECTION ...Flaw Detection - Other, Hull, Materials Used Undersea, Penetrating Ray, Standards, Specifications, ...**8.0218**

Test Methods

EVALUATION OF BOOTTOP PAINT SYSTEMS FOR OCEAN-GOING SHIPS IN A BOOTTOP PAINT TESTING MACHINE ...Catalysts, Paint - General, Primers, Surface Cleaning, Finishing, Water, ...**8.0237**

MECHANICAL PROPERTIES ...Environment General, Liquid, Mechanical Properties, Special Mission Ships, Submersibles, ...**8.0210**

Instrumental Services

PRESSURE INSENSITIVE VELOCIMETER ...Acoustical, Pressure, Transducers, Velocimeter, Velocity, ...**8.0055**

ADVANCE SONAR SYSTEMS ...Data Display, Sonar, Sonar and Echo Sounding, Testing Facilities, Transducers, ...**8.0096**

IMPROVED STANDARDS FOR RADIO AND ELECTRONIC EQUIPMENT ...Navigation, ...**4.0093**

BIOLOGICAL INSTRUMENTATION ...Behavioral Ecology, Biological Sciences, Instrumentation-general, Navigation Systems-other, ...**8.0064**

X-RADIOGRAPHIC AND ELECTRONIC FLUOROSCOPIC EQUIPMENT ...Core Analysis, Equipment Purchase Operation, Radiograph, Radiometer, X Ray Tubes, ...**8.0094**

DEVELOPMENT OF AN INSTRUMENT FOR MEASURING THE CONCENTRATION OF DISSOLVED OXYGEN IN SEA WATER IN SITU ...Chemical Analysis (water), Gases, Oxygen, Technique Development, Telemetry-other, ...**8.0092**

TEMPERATURE MICROSTRUCTURE AT THE OCEAN FLOOR ...Heat Flow Measurements, Oregon, Physical Properties, Technique Development, Temperature, ...**1.0188**

DIGITIZING SYSTEM FOR OCEANOGRAPHIC DATA ...Analog-digital Converters, Applied Electronics, Bathymetry, Digital Computers, Seismic Studies, Spectral Analysis, ...**4.0039**

MARINE ATMOSPHERIC RESEARCH FACILITY ...Air-sea Boundary-general, Meteorological Studies, Platforms, Telemetry-other, Turbulence, Weather Modification-general, ...**8.0322**

OCEAN BOTTOM EMPLACED GEOPHYSICAL STATION ...Automatic Stations, Benthonic-bottom, Dynamic Gravimeters, Geophysical Equipment, Gravity Studies, Pacific Ocean-east, Temperature, Water Motion Recorders, ...**4.0035**

NEW SEA GRAVITY METER ...Capacitance, Geophysical Equipment, Gravimetric, Gravity Studies, Transducers, ...**8.0067**

INSTRUMENT STUDIES ...Electronic Components-other, Evaluation Other, Testing Facilities, ...**8.0104**

MICROWAVE RADIOMETER DEVELOPMENT ...Microwave Radiation, Microwave Techniques, Radiation Detection, Radiation-terrestrial, Wave Form, ...**8.0056**

BIOTELEMETRY ...Marine Biology, Marine Biology (non-specific), Telemetry, ...**8.0070**

OCEAN ENGINEERING STUDIES ...Applied Electronics, Data Acquisition, Data Processing Services, Engineering Studies-general, Laboratory Analysis, Sonar, ...**8.0052**

MOVABLE OCEAN MEASUREMENT SYSTEM ...Acoustical, Platforms, Spectral Distribution, Spectrum, ...**8.0117**

UNDERWATER ACOUSTIC HOLOGRAPHIC DISPLAY ...Acoustical, Detectors, Holography, Photography, Recognition Systems, ...**8.0137**

DEEP SUBMERGENCE DISSOLVED OXYGEN TRANSDUCER ...Gases, Oxygen, Submersibles, Transducers, ...**8.0057**

A DESIGN PROGRAM FOR SUPERCONDUCTING ELECTRICAL MACHINES ...Electrical, Electromechanical Design, Marine Propulsion, Superconductive Device, ...**8.0132**

AEROLOGICAL INSTRUMENTS ...Amplifiers, Field Testing, Humidity Instruments, Microwave Techniques, Technique Development, ...**8.0082**

VISCOSITY AND VISCOELASTICITY OF LIQUIDS AND GLASSES ...Glass, Liquid, Morphology, State Variables - Pvt, Viscoelasticity, Viscosity, ...**8.0260**

CONSULTATIVE AND ADVISORY SERVICES - BATTERY PROBLEMS ...Batteries, Consultants, Advisory Services, Standards, Specifications, ...**11.0021**

AIRBORNE REMOTE SENSING OCEANOGRAPHY PROJECT ...Aircraft, Data Acquisition, Photography, Radar, Satellites, ...**4.0155**

EXPERIMENTAL SEA ICE OBSERVATIONAL TECHNIQUES ...Data Acquisition, Imaging, Range and Tracking-other, Satellites, Sea Ice, ...**4.0156**

SONAR ACCURACY ...Acoustic, Acoustical, Fire Control, Platforms, Sonar, Transmission, ...**1.0051**

EVALUATION OF CONTEMPORARY ACOUSTIC, MAGNETIC AND GRAVIMETRIC METHODS FOR DETERMINING SIZE AND SHAPE OF DEPOSITS ...Geophysical Equipment, Gravity Studies, Magnetic Studies, Sonar, Survey Studies, ...**7.0007**

FEASIBILITY STUDY OF THE USE OF ELECTRICAL METHODS FOR DETERMINING SIZE AND SHAPE OF DEPOSITS ...Dimensions-distribution, Electric Logging, Methodology, Ocean Mining, Technique Development, ...**7.0008**

TESTING AND EVALUATION OF MAGNETOMETER/GRADIOMETER AND TOW VEHICLE SYSTEM ...Evaluation Other, Field Testing, Magnetic Studies, Ore Deposits, Placer, ...**8.0116**

OCEAN ENGINEERING ...Bathymetry, Commercial Fishing, Fishing Gear, Telemetry-other, ...**8.0152**

IRRADIATION SERVICES AND STUDIES ...Fish & Shellfish, Fish -non-specific, Radiation, ...**6.0036**

FISH GUIDING ...Animal Distr. (non-specific), Control Systems, Fish -non-specific, Management -other, Water Environment - other, ...**8.0015**

DEVELOPMENT OF FISHNET BATHYKMORGRAPH ...Commercial Fishing, Fishing Gear, Nets, Readout Systems, ...**8.0102**

COAST GUARDS COASTAL OCEANOGRAPHIC MONITORNG NETWORK ...Automatic Stations, Buoys, Recording Systems, Telemetry-other, Transducers, ...**4.0006**

Instrumentation Design

Dimension

Dimension-three

COMPUTATION OF PERIODIC PROPELLER FORCES IN NON-UNIFORM FLOWS USING A LIFTING SURFACE MODEL ...Marine Propulsion, Models, Non-steady Flow, Rotors-propellers, Turbulent, ...**8.0180**

Dimension-two

UNSTEADY TWO-DIMENSIONAL CAVITY FLOWS ...Boundary Problems, Cavity Flow, Concept, Model Apparatus-other, Unsteady, ...**8.0186**

VORTEX WAKE SHEDDING OF A HEAVING CIRCULAR CYLINDER ...Configuration of Body, Reynolds Number, Ship Resistance Stability, Vortex, Wake, ...**8.0191**

Mathematical Models

WATER-TO-AIR RETRIEVAL ...Aircraft, Recovery Operations, Suspension-release, ...8.0276

ANALYSIS OF INLAND CARGO CONSOLIDATION CENTERS ...Data Reduction and Analysis, Development of Models, Freight, Loading/unloading, Warehouses, ...8.0032

Measuring Devices

Distance-measuring-device

VISUAL RANGE METERS ...Fog-haze-mist, Guidance, Landing, Meteorological Conditions, Visibility, ...8.0072

MISCELLANEOUS SERVICES FOR FEDERAL AVIATION AGENCY (VISUAL RANGE) ...Air-sea Boundary-general, Fog-haze-mist, Visibility, ...3.0011

Fluids

AUTOMATED FLOW SYSTEM CALIBRATION ...Aircraft, Controls, Digital Computer Applications, Transducers, ...8.0071

Force

MECHANICAL TESTS AND FORCE CALIBRATIONS ...Standards, Specifications, ...8.0073

Humidity

HUMIDITY CALIBRATION ...Humidity Instruments, Standards, Specifications, ...8.0084

Measuring Devices-other

DESIGN OF RUBBLE WAVE-ABSORBER ...Beaches, Energy Dissipators, Harbors, Shoreline Structures, Waves, ...8.0037

ESTIMATION OF HULL STEEL WEIGHTS FROM MIDSHIP SECTION CHARACTERISTICS ...Bulkheads, Engineering Studies-other, Naval Architecture-general, ...8.0303

WEIGHT ANALYSIS IN FISHING BOATS ...Approximations, Hull, Low Alloy Steels, Pressure Effects, ...8.0295

Pressure

OCEAN PRESSURE RESEARCH ...Military Aspects, Ordnance, Underwater Warfare, ...1.0173

LABORATORY MODEL STUDIES ON PRESSURE DISTRIBUTION IN DETRITUS DURING PENETRATION ...Laboratory Analysis, Mechanical Properties, Model Studies, Placer, Soil Loads, ...8.0253

Stress Recorders

AN INVESTIGATION OF THE S/N FATIGUE LIFE GAGE ...Random, ...8.0100

Temperature

OPERATIONAL EVALUATION OF NSRT SYSTEM ...Equipment, Special Mission Ships, Surface Environments, ...8.0059

Requirement

OPTIMIZATION METHODS APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL AUXILIARY ...Algorithms, Cost Analysis, Engineering Studies-other, Optimization Technique, Other-design-and-construction, ...8.0297

Instrumentation-general

OCEANOGRAPHIC DATA SYSTEMS ...Acoustical, Data & Statistics Storage, Engineering Studies-other, Hydrodynamics, Pollution Sources-general, ...4.0013

SATELLITE INTERROGATE ENVIRONMENTAL BUOY DEVELOPMENT ...Navigation Communication, Satellites, ...8.0308

BIOLOGICAL INSTRUMENTATION ...Behavioral Ecology, Biological Sciences, Instrumental Services, Navigation Systems-other, ...8.0064

DATA COLLECTION ...Charts, Data Acquisition, Data Analysis - General, Sampling, ...4.0017

SUPPORT OF RESEARCH VESSEL VELERO 4 ...California, Equipment Purchase Operation, Facilities, Geology-general, Marine Biology, Training Grants, Fellowships, ...4.0115

SYMPOSIUM ON RESEARCH NEEDS AND PRIORITIES FOR MARINE GEOLOGY OF THE GULF OF MEXICO ...Continental Shelf, Gulf of Mexico, Mechanical Properties, Meetings, Sedimentation, Structural Studies, ...11.0040

DETERMINATION OF EQUATION OF STATE, VISCOSITY AND COMPRESSIBILITY OF SEA WATER ...Acoustical, Currents-other, Density, Salinity, Temperature, Viscosity, ...1.0145

FOULING OF SENSORS ...Fouling, Inhibitors, Marine Biology, Organometallics, ...8.0239

OCEANOGRAPHIC RESEARCH ...Acoustical, Hydrodynamics, Moorings, Naval Architecture-general, Water Motion Recorders, ...1.0052

SHALLOW WATER OCEANOGRAPHY (SEALAB III) ...Diving and Scuba, Diving-system, Environmental Effects-geologic, Underwater-laboratory, ...1.0146

BIOLOGICAL OCEANOGRAPHY & DETERIORATION - SHALLOW WATER MARINE SEDIMENTS & WATER COLUMN BACTERIA ...Biology, Continental Shelf, Marine Bacteria, Nephelometry, Vertical Distribution, ...5.0807

ARCTIC UNDERSEAS RESEARCH, JOINT USA-CANADIAN HEAT BUDGET STUDY ...Arctic, Heat and Radiation Transfer, Physical Climatology, Sea Ice, ...3.0071

SPACECRAFT OCEANOGRAPHY ...Instrumentation, Management, Photography, Satellites, Unmanned Satelite, ...4.0157

SYSTEM OPERATIONS AND ACOUSTIC PHYSICS ...Acoustical, Economic Theory, Liquids, Standards, Specifications, Systems Analysis, ...12.0020

ACOUSTIC PROPAGATION STUDIES ...Acoustical, Technique Development, Transmission, ...1.0044

GREAT LAKES RESEARCH - MONITORING OF WATER CHARACTERISTICS ...Data Acquisition, Forecasting-prediction, Geophysical Analysis, Great Lakes-general, Temperature, ...1.0185

PHYSICAL OCEANOGRAPHY ...Buoys, Model Studies, Pacific Ocean-north, ...1.0160

Intertidal Areas

ESTUARINE SEDIMENTATION PROCESSES ...Estuaries, General Deposition, Morphology-general, New England Province, Tidal Streams, Tides, ...7.0244

A STUDY OF THE ECOLOGY OF THE MICROFAUNA LIVING BETWEEN INTERTIDAL MARINE SEDIMENTS ...Beach, Copepods, Crustacea -non-specific, New England Province, Salinity, ...5.0793

QUATERNARY ENVIRONMENTS AND BIOTAS ...Biofacies, Paleotemperature, Population - Distribution, Quaternary Period, Western, ...7.0157

STUDENT RESEARCH AT THE MARINE SCIENCE CENTER ...Facilities, Invertebrate Physiology, Invertebrates -non-specific, Oregon, Training Grants, Fellowships, ...11.0039

THE SEDIMENTARY AND DIAGENETIC RECORD OF ENVIRONMENTAL PARAMETERS IN RECENT BAHAMIAN TIDAL FLATS ...British West Indies, Diagenesis, Environmental Effects-geologic, Local Stratigraphy, Paleoclimatology, ...7.0163

MARINE ECOLOGICAL STUDIES ...Environmental Ecology, Habitat Studies, Invertebrates -non-specific, Stress, ...5.0917

GULF OF CALIFORNIA BIOLOGY ...Arid and Desert, Bioluminescence, Gulf of California, Population Dynamics, Tropic, ...5.0856

INTERACTIONS OF INTERTIDAL POPULATIONS ...Competition, Habitat Studies, Population Dynamics, Predation, ...5.0864

TRANSVERSAL DRIFTS IN BOTTOM PROFILE ...Bathymetry, Benthonic-bottom, Ocean Waves - Currents, Waves, ...7.0224

THE BIOLOGY OF THE INFAUNA OF A TROPICAL SOFT BOTTOM AREA ...Aquatic Ecology, Benthic Fauna, Estuaries, Florida, Pollution - Effects of , ...5.0879

PHYSIOLOGICAL VARIATION IN SUBTIDAL AND INTERTIDAL MARINE INVERTEBRATES ...Habitat Studies, Invertebrates -non-specific, ...5.0548

THE ORIGIN OF GRAVEL BARS IN THE INTERTIDAL ZONE, PARRSBORO HARBOUR, NOVA SCOTIA, CANADA ...Canada, Location, Origin, Sand Bars, Size, ...7.0277

STRATIGRAPHY OF RECENT INTERTIDAL SEDIMENTMENTARY DEPOSITS OF THE SHEEPSHEAD MUDFLAT, NEW JERSEY ...New Jersey, Quaternary Period, Sediments-other, Stratigraphy-general, ...7.0274

LITTORAL ENVIRONMENT OBSERVATION PROGRAM ...California, Development, Erosion, ...7.0289

NATURE OF INTERTIDAL EROSION ON CORAL ATOLLS ...Atolls, Erosion, Fossil Limestone, Marine Biology (non-specific), ...7.0210

Invertebrate Anatomy

PARASITIC COPEPODA %CRUSTACEA*ROM INVERTEBRATES AND FISHES ...Animal Taxonomy, Copepods, Ectoparasites, Indian Ocean-general, ...5.0451*

THE OSTRACODA OF THE BAY OF NAPLES ...Environmental Ecology, Italy, Life History Studies, Nomenclature, Classification, Shrimps - Seed Or Mussel, ...5.0415

RESEARCH ON INDO-WEST PACIFIC MARINE MOLLUSKS OF THE FAMILY CONIDAE ...Animal Taxonomy, Gastropods -slugs,conch,snails, Indian Ocean-general, Number Or Density, ...5.0517

ECOLOGICAL AND EVOLUTIONARY IMPLICATIONS OF THE ECOTYPES OF ESTUARINE CRUSTACEA ...Classical, Estuaries, Isopods, Metabolism, Productivity - Food Chain, ...5.0418

CONTINUED STUDIES OF THE SYSTEMATICS AND ZOOGEOGRAPHY OF WESTERN ATLANTIC CAECIDAE ...Animal Taxonomy, Atlantic Ocean-general, Derivatives, Gastropods -slugs,conch,snails, Pubilications -other, ...5.0696

CHONOTRICH CILIATE PROTOZOANS ...Age, Animal Taxonomy, Ciliates, Life History Studies, Range Or Territorial Distr. , ...5.0742

A COMPARATIVE SYSTEMATIC INVESTIGATION OF MARINE CILIATES IN THE HOLOTRICHOUS PROTOZOAN ORDER HYMENOSTOMATIDA ...Animal Taxonomy, Cilia and Flagellae, Ciliates, Comparative Physiology, ...5.0840

CYTOTAXONOMY OF SPECIES OF RELATED PELECYPOD MOLLUSKS ...Animal Taxonomy, Clams, Derivatives, Oysters, Selection & Breeding, ...5.0413

NORTH AMERICAN POST-OLIGOCENE CYTHERID OSTRACODS ...Animal Taxonomy, Life History Studies, Nearctic, Phylogenies, Shrimps - Seed Or Mussel, ...7.0179

REPRODUCTIVE RELATIONSHIPS AMONG POPULATIONS OF A MARINE WOOD-BORING ISOPOD ...Animal Taxonomy, Isopods, Population Dynamics, Reproductive System, ...5.0414

SYSTEMATIC STUDIES OF SPONGES OF THE JAMAICAN FORE-REEF SLOPE ...Animal Taxonomy, Habitat Studies, Jamaica, Porifera, Reefs, ...5.0558

MORPHOLOGY AND PHYSIOLOGY OF THE HEART OF ECTEINASCIDIA TURBINATA ...Bermuda, Cardiovascular, Sea Squirts - Tunicates, ...5.0530

SYSTEMATICS, BIOLOGY, AND HYDROGRAPHIC RELATIONS OF SOME SPECIES OF CALANUS (CRUSTACEA, COPEPODA) ...Animal Taxonomy, Copepods, Oceanic Fronts, Vertical Distribution, ...5.0367

MORPHOLOGY, PHYSIOLOGY AND ECOLOGY OF MARINE LAMELLIBRANCHS ...Aquatic Ecology, Basic Embryology, Behavior, Freshwater Mussels, Scallops, ...5.0479

SYSTEMATICS MORPHOLOGY AND ECOLOGY OF THE GENUS ERVILIA (MOLLUSCA: PELECYPODA) IN THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean-general, Ecology (animal), Freshwater Mussels, Scallops, ...5.0458

ULTRASTRUCTURE OF EARLY CLEAVAGE STAGES IN THE EGG OF LYMNAEA SP ...Basic Embryology, Cell Cycle, Electron Microscopy, Gastropods -slugs,conch,snails, Microtubules, ...5.0509

COMPARATIVE MORPHOLOGY OF MARINE NEMATODES ...Comparative Physiology, Histology and Cytology, Musculoskeletal System, Nematoda -other, ...5.0567

SYSTEMATICS AND MORPHOLOGY OF THE SIPUNCULID LARVAE OF THE INDIAN OCEAN ...Animal Taxonomy, Developmental Physiology, Indian Ocean-general, Invertebrates -non-specific, ...5.0765

DIAGNOSTIC CHARACTERS & DEVELOPMENT OF EXTERNAL GENITALIA IN JUVENILE GROOVED SHRIMPS OF GENUS PENAEUS FROM WESTERN ATLANTIC ...Atlantic Ocean-general, Developmental Physiology, Reproductive System, Shrimps - Common, ...5.0405

DEMINERALIZATION-BORING MECHANISMS OF MOLLUSKS ...Calcification, Gastropods -slugs,conch,snails, Invertebrate Physiology, Metabolism, ...5.0459

THE PROCESS OF DEMINERALIZATION-BORING IN BIVALVES ...Calcification, Derivatives, Freshwater Mussels, Scallops, Invertebrate Physiology, ...5.0366

THE STRUCTURE AND FUNCTION OF CRUSTACEAN EYES ...Crustacea -non-specific, Light -other, Oceanic - Pelagic, Vertical Distribution, Visual Organs, ...5.0363

STRUCTURE AND FUNCTION OF EYES ...Vertebrate Anatomy, Visual Organs, ...5.0379

Invertebrate Nutrition

A NEW APPROACH TO NUTRITION, PHYSIOLOGY, AND MINERAL CYCLING OF FORAMINIFERA ...Axenic Culture, Foraminifera, Metabolism, Productivity - Food Chain, ...5.0809

UTILIZATION OF ENVIRONMENTAL NUTRITIONAL RESOURCES BY STARFISH ...Digestive System, Environmental Physiology, Maturity & Growth Stages, Metabolism, Starfishes, ...5.0591

NUTRITIONAL STUDIES ON MARINE ORGANISMS ...Crustacea -non-specific, Nutrition Studies, Organics, Phytoplankton, ...5.1001

LARVAL DEVELOPMENT OF SCYLLARIDEAN LOBSTERS ...Animal Taxonomy, Developmental Physiology, Environmental Physiology, Laborator: Lobsters, ...5.0409

EVOLUTIONARY DIVERGENCE OF ONUPHID POLYCHAETES ...Comparative Physiology, Environment Resistance, Environmental Physiology, Lugworms, Marine Segmentedworm, Water Temperature-non-specific, ...5.0663

THE ROLE OF COPROPHAGY IN MARINE FOOD CHAINS ...Feces, Nutrition -other, Productivity - Food Chain, ...5.0963

OYSTER FATNESS STUDY ...Aquaculture & Fish-farming, Fats - Lipids & Oils, Food Supply, Growth Rate, Oysters, ...5.0512

ALGAE AS FOOD FOR MARINE INVERTEBRATE LARVAE HELD IN THE LABORATORY ...Algal Culture, Bulk Culture -other, Chesapeake Bay, Invertebrates -non-specific, ...5.0732

THE BIOLOGY OF ROCK-BORING SIPUNCULIDS ...Caribbean Sea, Invertebrate Physiology, Invertebrates -non-specific, Reefs, ...5.0577

PROTOZOOLOGY ...Animal Taxonomy, Axenic Culture, Histology and Cytology, Protozoa, ...5.0443

SYMBIOSIS IN CONVOLUTA ...Algae- General, Eddyworms, Symbiosis, ...5.0713

NUTRIENT STORES IN REPRODUCTION IN SEA INVERTEBRATES ...Crabs, Decapoda -other, Reproductive System, Starfishes, ...5.0949

UPTAKE OF ORGANIC COMPOUNDS BY MARINE INVERTEBRATES ...Amino Acids, Amino Acids -non-specific, Chemoreceptors, Invertebrates -non-specific, Marine Biology, Metabolism, Pulse-labelling, ...5.0938

Invertebrate Pathology

MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...Bays, Mortality Rates, Oregon, Oysters, Pathology, ...5.0488

STUDIES IN OYSTER PATHOLOGY ...Mortality Rates, Oysters, Pathology, Tissues, ...5.0519

PACIFIC OYSTER MORTALITY STUDIES ...Mortality Rates, Oysters, Pacific Ocean-general, Pathology, ...5.0442

HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE INVERTEBRATES ...Clams, Contamination - Water, Pathology, Pollution - Effects of , Pollution Effects, Pollution Sources-other, ...5.0497

THE DISEASES OF INVERTEBRATE ANIMALS ...Developmental Physiology, Immumology, Tumors, ...5.0536

STUDIES ON THE PROTISTAN CAUSING MALPEQUE DISEASE ...Myxomycetes, Oysters, Pathology, Plant Taxonomy, Range Or Territorial Distr. , ...5.0498

BIOLOGICAL ACTIVITIES OF MARINE FUNGI ...Endoparasites -other, Host-parasite Interactions, Marine Fungi (non-specific), Oysters, Pathological Physiology, Plant Developmental Biology, ...5.0699

Invertebrate Physiology

CHEMISTRY AND BIOLOGY OF SOME COELENTERATE NEMATOCYSTS ...Animal Toxins, Cell. organ. & Organoids - ot, Coelenterata -other, Predation, ...5.0776

STUDENT RESEARCH AT THE MARINE SCIENCE CENTER ...Facilities, Intertidal Areas, Invertebrates -non-specific, Oregon, Training Grants, Fellowships, ...11.0039

GROWTH LAYERING IN BIVALVED MOLLUSKS - AN AID IN PALEOBIOGEOGRAPHIC INTERPRETATION ...Animal Taxonomy, Biological Rhythms, Environmental Physiology, Freshwater Mussels, Scallops, Growth Rate, ...5.0355

CUES INVOLVED IN VERTICAL MOVEMENT AND STATIC ORIENTATION OF GASTROPODS ...Behavior, Gastropods - slugs,conch,snails, Light -other, Locomotion, ...5.0462

INVESTIGATIONS OF THE INDUCING CAPACITY OF THE POLAR LOBE IN THE DEVELOPMENT OF THE MARINE

GASTROPOD ILYANASSA OBSOLETA ...Developmental Physiology, Gastropods -slugs,conch,snails, ...5.0417

FINE STRUCTURE OF JELLYFISH (CHRYSAORA QUINQUICERA) TENTACLE MUSCLE ...Contraction and Relaxation, Jelly Fish, Microscopy -other, Musculoskeletal System, Skin Or Ectoderm, ...5.0659

THE BIOLOGY OF ROCK-BORING SIPUNCULIDS ...Caribbean Sea, Invertebrate Nutrition, Invertebrates -non-specific, Reefs, ...5.0577

DEMINERALIZATION-BORING MECHANISMS OF MOLLUSKS ...Calcification, Gastropods -slugs,conch,snails, Invertebrate Anatomy, Metabolism, ...5.0459

THE PROCESS OF DEMINERALIZATION-BORING IN BIVALVES ...Calcification, Derivatives, Freshwater Mussels, Scallops, Invertebrate Anatomy, ...5.0366

MECHANISMS OF VENTILATORY CONTROL ...Crabs, Nervous System, Respiratory System, ...5.0471

Behavior

PHYSIOLOGICAL MECHANISMS UNDERLYING THE BEHAVIOR OF MARINE CRUSTACEA ...Behavioral Ecology, Crabs, Shrimps - Common, ...5.0428

VISUAL AND ACOUSTICAL COMMUNICATION IN CERTAIN MARINE CRUSTACEANS ...Atlantic Ocean-north, Auditory, Crabs, Visual Organs, ...5.0430

TEMPERATURE NEEDS FOR GONADAL DEVELOPMENT AND SPAWNING OF DIFFERENT PHYSIOLOGICAL RACES OF THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA ...Biological Rhythms, Environmental Physiology, Oysters, Reproductive System, Water Temperature-non-specific, ...5.0352

PREDATOR PREY RELATIONSHIPS BETWEEN ECHINODERMS AND MOLLUSCE ...Behavioral Ecology, Gastropods -slugs,conch,snails, Predation, Starfishes, ...5.0351

LEARNING IN OCTOPUS ...Learning and Retention, Octopus, Squid, Cuttlefish... , Travel Grants, ...5.0491

CUES INVOLVED IN VERTICAL MOVEMENT AND STATIC ORIENTATION OF GASTROPODS ...Gastropods -slugs,conch,snails, Invertebrate Physiology, Light -other, Locomotion, ...5.0462

LIFE HISTORY AND DEVELOPMENT OF POLYCHAETOUS ANNELID LARVAE ...Developmental Physiology, Life History Studies, Lugworms, Marine Segmentedworm, Reproductive System, Whole Body Culture & Rearing, ...5.0604

BIOLOGICAL SOUND ...Sound Production, ...1.0064

MORPHOLOGY, PHYSIOLOGY AND ECOLOGY OF MARINE LAMELLIBRANCHS ...Aquatic Ecology, Basic Embryology, Freshwater Mussels, Scallops, Invertebrate Anatomy, ...5.0479

TEMPERATURE TOLERANCE OF MARINE ANIMALS THROUGH BEHAVORIAL RESPONSES ...Environment Resistance, Mortality Rates, Thermal, Water Temperature-non-specific, ...5.0118

THERMAL PREFERENCES OF MARINE FISHES AND INVERTEBRATES ...Fish -non-specific, Invertebrates -non-specific, Thermal, Water Temperature-non-specific, ...5.0209

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...Basic Embryology, Clams, Maturity & Growth Stages, Oysters, Ph, Acidity -water, ...5.0373

NEUROPHYSIOLOGICAL MECHANISMS IN BEHAVIOR ...Giant Water Bug, Water Strider, Horseshoe Or King Crabs, Locomotion, Proprioceptors, ...5.0490

CONDUCTION AND INTEGRATION ...Cellular Physiology, Hydra, Portuguese Man-of-war, Katydids, Musculoskeletal System, Nervous System, ...5.1018

NEURAL MECHANISMS OF LEARNING AND BEHAVIOR ...Brain, Gastropods -slugs,conch,snails, Learning and Retention, Mech of Transmission, ...5.0485

Biological Rhythms

TEMPERATURE NEEDS FOR GONADAL DEVELOPMENT AND SPAWNING OF DIFFERENT PHYSIOLOGICAL RACES OF THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA ...Behavior, Environmental Physiology, Oysters, Reproductive System, Water Temperature-non-specific, ...5.0352

EXPERIMENTAL MANIPULATION OF MECHANICAL AND PHYSIOLOGICAL RHYTHMS - A DUAL APPROACH TO THE BIOLOGICAL CLOCK PROBLEM ...Acetabularia, Behavioral Ecology, Crabs, Perching Birds - Songbirds, ...5.1002

RESEARCH ON THE BIO-SYSTEMATICS OF THE CIRRIPEDIA ...Barnacles, Developmental Physiology, Visual Organs, ...5.0364

ECOLOGICAL, EXPERIMENTAL AND COMPUTER STUDIES OF ENDOGENOUS RHYTHMICITY ...Brain, Computer Methods -general, Crustacea -non-specific, Locomotion, ...5.0361

REPRODUCTION AND EMBRYONIC SURVIVAL IN ASCIDIA NIGRA (SAVIGNY) ...Basic Embryology, Laboratory, Reproductive System, Sea Squirts - Tunicates, Whole Body Culture & Rearing, ...5.0600

GROWTH LAYERING IN BIVALVED MOLLUSKS - AN AID IN PALEOBIOGEOGRAPHIC INTERPRETATION ...Animal Taxonomy, Environmental Physiology, Freshwater Mussels, Scallops, Growth Rate, Invertebrate Physiology, ...5.0355

STUDIES ON MOLTING, GROWTH, AND DEVELOPMENT IN ACORN BARNACLES AND LARVAL DECAPODS ...Barnacles, Developmental Physiology, Endocrine System, Fouling, ...5.0296

PURCHASE OF MATERIALS FOR & CONSTRUCTION OF, FLOATS, RACKS, BAGS, AND TRAYS FOR THE SUSPENSION OF VARIOUS TYPES OF CULTCH ...Derivatives, Equipment Purchase Operation, Oysters, Spawning & Nesting Sites, Stocking of Fish & Shellfish, ...8.0008

SURVIVAL REQUIREMENTS OF JUVENILE AND ADULT BLUE CRABS ...Crabs, Environmental Physiology, Maturity & Growth Stages, Osmoregulation, Salinity, Size, ...5.0475

ADULT SHRIMP STUDIES ...Alaska, Bays, Habitat Studies, Life History Studies, Shrimps - Common, ...5.0340

INITIATION OF METAMORPHOSIS IN AURELIA ...Growth Rate, Jelly Fish, Low Temp. -but Above 32f, Metabolism, Water Light Quality & Quantity, ...5.0599

PHYSIOLOGY OF THE LIMULUS HEART ...Cardiovascular, Heart, Horseshoe Or King Crabs, Nervous System, ...5.0463

Bioluminescence

PHYSICAL AND BIOLOGICAL OCEANOGRAPHY OF A LUMINOUS BAY ...Bays, Circulation-general, Jamaica, Model Studies, Phytoplankton, ...5.0976

MECHANISM STUDIES ON BIOLUMENESCENT REACTIONS WITH EMPHASIS ON ENERGY TRANSFER PROBLEMS ...Energy Conversion, Luciferase, Luciferin, ...1.0164

MID-DEPTH BIOLUMINESCENCE ...Crustacea -non-specific, Vertical Distribution, ...1.0162

BIOSYNTHESIS OF BROMOPHENOLS IN MARINE INVERTEBRATES ...Acorn Worms, Metabolism, Phenols, ...5.0961

GULF OF CALIFORNIA BIOLOGY ...Arid and Desert, Gulf of California, Intertidal Areas, Population Dynamics, Tropic, ...5.0856

PHYSIOLOGY OF LUMINESCENT SIGNAL SYSTEMS ...Photoreception, Trace Elements, Visual Organs, ...5.0950

SEALAB III PARTICIPATION ...Behavioral Ecology, Divers, Diving and Scuba, Medical Studies, Submersibles, ...6.0091

Blood and Lymph

BIOCHEMICAL CHARACTERIZATION OF CHOLINESTERASES IN THE BLOOD ANDCENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Cholinesterase, Enzyme-substrate, Horseshoe Or King Crabs, Nervous System, Reaction Rates, ...5.0468

Blood Typing Studies

THE COMPARATIVE IMMUNOLOGY OF LOWER ORGANISMS ...Comparative Physiology, Immumology, Serology and Immunology, ...5.0556

Calcification

HISTOCHEMICAL STUDIES OF MUCOSUBSTANCES IN THE MANTLE OF THE NORTHERN QUAHOG, MERCENARIA MERCENARIA ...Clams, Derivatives, Histochemistry - Cytochem, Mucopolysaccharides, Mucoproteins, ...5.0455

ULTRASTRUCTURAL AND AUTORADIOGRAPHIC INVESTIGATION OF CALCIFICATION IN FORAMINIFERS ...Calcium, Cell Wall, Cell. organ. & Organoids -ot, Foraminifera, Histology and Cytology, Invertebrate Culture, ...5.0788

CALCIFICATION MECHANISMS IN MARINE ORGANISMS ...Algae- General, Marine Plants, Mollusks -non-specific & Other, ...5.1016

DEMINERALIZATION-BORING MECHANISMS OF MOLLUSKS ...Gastropods -slugs,conch,snails, Invertebrate Anatomy, Invertebrate Physiology, Metabolism, ...5.0459

THE PROCESS OF DEMINERALIZATION-BORING IN BIVALVES ...Derivatives, Freshwater Mussels, Scallops, Invertebrate Anatomy, Invertebrate Physiology, ...**5.0366**

Cardiovascular

NEUROPHYSIOLOGICAL INVESTIGATIONS OF LIMULUS CENTRAL NERVOUS SYSTEM ...Brain, Horseshoe Or King Crabs, Nervous System, ...**5.0469**

THE EFFECT OF SOME NEUROTRAMSMITTERS ON THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Brain, Horseshoe Or King Crabs, Nerve Effects, Neuroeffective, ...**5.0470**

MORPHOLOGY AND PHYSIOLOGY OF THE HEART OF ECTEINASCIDIA TURBINATA ...Bermuda, Invertebrate Anatomy, Sea Squirts - Tunicates, ...**5.0530**

PHYSIOLOGY OF THE LIMULUS HEART ...Biological Rhythms, Heart, Horseshoe Or King Crabs, Nervous System, ...**5.0463**

Comparative Physiology

STUDIES ON THE STRUCTURE OF HEMERYTHRIN ...Biochemical, Configuration, Hemerythrin, Invertebrates -non-specific, ...**5.0993**

TREMATODES OF FISHES OCCURRING ON THE WEST COAST OF NORTH AMERICA. ...Collections, Nearctic, Pacific Ocean-general, Trematoda -other, ...**5.0636**

A COMPARATIVE SYSTEMATIC INVESTIGATION OF MARINE CILIATES IN THE HOLOTRICHOUS PROTOZOAN ORDER HYMENOSTOMATIDA ...Animal Taxonomy, Cilia and Flagellae, Ciliates, Invertebrate Anatomy, ...**5.0840**

WATER AND SALT REGULATION IN NEREID POLYCHAETES ...Active Transport, Lugworms, Marine Segmentedworm, Osmoregulation, Salt, ...**5.0648**

COMPARATIVE MORPHOLOGY OF MARINE NEMATODES ...Histology and Cytology, Invertebrate Anatomy, Musculoskeletal System, Nematoda -other, ...**5.0567**

THE COMPARATIVE IMMUNOLOGY OF LOWER ORGANISMS ...Blood Typing Studies, Immumology, Serology and Immunology, ...**5.0556**

Digestive System

UTILIZATION OF ENVIRONMENTAL NUTRITIONAL RESOURCES BY STARFISH ...Environmental Physiology, Invertebrate Nutrition, Maturity & Growth Stages, Metabolism, Starfishes, ...**5.0591**

IONIC REGULATION IN THE QUEEN CONCH, STROMBUS GIGAS LINNAEUS ...Blood Plasma and Serum, Gastropods - slugs,conch,snails, Osmoregulation, ...**5.0407**

EVOLUTIONARY DIVERGENCE OF DEEP WATER MARINE ANNELIDS ...Comparative Physiology, Environmental Physiology, Lugworms, Marine Segmentedworm, Vertical Distribution, ...**5.0662**

FOOD AND EXPERIMENTAL ENVIRONMENTS (SHRIMP AQUACULTURE PROGRAM) ...Aquaculture & Fish-farming, Captive Rearing, Food Supply, Shrimps - Common, Water Environment -other, ...**5.0505**

Cellular Or Intracellular

INTESTINAL ADSORPTION AND TRANSPORT OF NUTRIENTS IN ECHINODERANS ...Active Transport, Echinodermata -other, Intestine, Metabolism, Sodium, ...**5.0619**

Intestine

INTESTINAL ADSORPTION AND TRANSPORT OF NUTRIENTS IN ECHINODERANS ...Active Transport, Cellular Or Intracellular, Echinodermata -other, Metabolism, Sodium, ...**5.0619**

Endocrine System

NEUROENDOCRINE REGULATION ...Brain, Crustacea -non-specific, Osmoregulation, Sodium, Water, ...**5.0426**

NEUROENDOCRINE PATHWAYS IN OSMOREGULATION IN CRUSTACEANS ...Aquatic Ecology, Crabs, Environmental Physiology, Osmoregulation, Shrimps - Common, ...**5.0427**

STUDIES ON MOLTING, GROWTH, AND DEVELOPMENT IN ACORN BARNACLES AND LARVAL DECAPODS ...Barnacles, Biological Rhythms, Developmental Physiology, Fouling, ...**5.0296**

NEUROSECRETION AND ENDOCRINE PHYSIOLOGY ...Configuration, Crustacea -non-specific, Diabetogenic, Ns, Hormones, Intermedin, ...**5.1023**

Environmental Physiology

AGING IN HYDROIDS ...Aging, Cell Injury and Autolysis, Developmental Physiology, Hydra, Portuguese Man-of-war, Senescence, ...**5.0597**

UTILIZATION OF ENVIRONMENTAL NUTRITIONAL RESOURCES BY STARFISH ...Digestive System, Invertebrate Nutrition, Maturity & Growth Stages, Metabolism, Starfishes, ...**5.0591**

MICROSTRATIFICATION OF MARINE ZOOPLANKTON ...Growth Rate, Thermal, Vertical Distribution, Zooplankton, ...**5.0753**

TEMPERATURE NEEDS FOR GONADAL DEVELOPMENT AND SPAWNING OF DIFFERENT PHYSIOLOGICAL RACES OF THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA ...Behavior, Biological Rhythms, Oysters, Reproductive System, Water Temperature-non-specific, ...**5.0352**

TEMPERATURE AND SALINITY TOLERANCE OF THE SAND SHRIMP, CRANGON SEPTEMSPINSOA ...Environment Resistance, Estuaries, Salinity, Shrimps - Common, Temperature, ...**5.0437**

LARVAL DEVELOPMENT OF SCYLLARIDEAN LOBSTERS ...Animal Taxonomy, Developmental Physiology, Invertebrate Nutrition, Laboratory, Lobsters, ...**5.0409**

EVOLUTIONARY DIVERGENCE OF DEEP WATER MARINE ANNELIDS ...Comparative Physiology, Digestive System, Lugworms, Marine Segmentedworm, Vertical Distribution, ...**5.0662**

EVOLUTIONARY DIVERGENCE OF ONUPHID POLYCHAETES ...Comparative Physiology, Environment Resistance, Invertebrate Nutrition, Lugworms, Marine Segmentedworm, Water Temperature-non-specific, ...**5.0663**

GROWTH LAYERING IN BIVALVED MOLLUSKS - AN AID IN PALEOBIOGEOGRAPHIC INTERPRETATION ...Animal Taxonomy, Biological Rhythms, Freshwater Mussels, Scallops, Growth Rate, Invertebrate Physiology, ...**5.0355**

NEUROENDOCRINE PATHWAYS IN OSMOREGULATION IN CRUSTACEANS ...Aquatic Ecology, Crabs, Endocrine System, Osmoregulation, Shrimps - Common, ...**5.0427**

SURVIVAL REQUIREMENTS OF JUVENILE AND ADULT BLUE CRABS ...Biological Rhythms, Crabs, Maturity & Growth Stages, Osmoregulation, Salinity, Size, ...**5.0475**

131.116B - LARVAL CULTURE (SHRIMP AQUACULTURE PROGRAM) ...Algal Culture, Aquaculture & Fish-farming, Captive Rearing, Food Supply, Shrimps - Common, ...**5.0500**

GROWTH, CONDITION, AND SURVIVAL OF SHELLFISH ...Adaptation, Maryland, Oysters, Water Quality-general, Water Salinity, ...**5.0447**

DEVELOPMENT OF CULTURE METHODS FOR ECOLOGICALLY IMPORTANT MARINE ZOOPLANKTON SPECIES ...Aquatic Ecology, Copepods, Invertebrate Culture, Zooplankton, ...**5.0834**

GENETIC REGULATION OF HEMOGLOBIN SYNTHESIS IN ARTEMIA ...Hemoglobin, Marker, Mutagens, Shrimps - Brine Or Fairy, ...**5.0365**

Immumology

THE DISEASES OF INVERTEBRATE ANIMALS ...Developmental Physiology, Invertebrate Pathology, Tumors, ...**5.0536**

THE COMPARATIVE IMMUNOLOGY OF LOWER ORGANISMS ...Blood Typing Studies, Comparative Physiology, Serology and Immunology, ...**5.0556**

Locomotion

ECOLOGICAL, EXPERIMENTAL AND COMPUTER STUDIES OF ENDOGENOUS RHYTHMICITY ...Biological Rhythms, Brain, Computer Methods -general, Crustacea -non-specific, ...**5.0361**

CUES INVOLVED IN VERTICAL MOVEMENT AND STATIC ORIENTATION OF GASTROPODS ...Behavior, Gastropods - slugs,conch,snails, Invertebrate Physiology, Light -other, ...**5.0462**

NEUROPHYSIOLOGICAL MECHANISMS IN BEHAVIOR ...Giant Water Bug, Water Strider, Horseshoe Or King Crabs, Proprioceptors, ...**5.0490**

Metabolism

A NEW APPROACH TO NUTRITION, PHYSIOLOGY, AND MINERAL CYCLING OF FORAMINIFERA ...Axenic Culture, Foraminifera, Invertebrate Nutrition, Productivity - Food Chain, ...**5.0809**

UPTAKE AND ASSIMILATION OF ORGANIC COMPOUNDS IN MARINE ORGANISMS ...Active Transport, Invertebrates - non-specific, Nutrition, Organics, Productivity - Food Chain, ...5.0937

UTILIZATION OF ENVIRONMENTAL NUTRITIONAL RESOURCES BY STARFISH ...Digestive System, Environmental Physiology, Invertebrate Nutrition, Maturity & Growth Stages, Starfishes, ...5.0591

CAROTENOIDS, CAROTENOID CHROMOPROTEINS, AND ASSOCIATED LIPIDS IN ANIMALS ...Carotenoid Pigments, Catabolism and Degradation, Pigments - Animal-non-specific, ...5.0944

AMINO ACID & PROTEIN METABOLISM IN SCHISTOSOMES ...Amino Acids -non-specific, Flukes, Helminths, Proteins -non-specific, ...5.0621

ECOLOGICAL AND EVOLUTIONARY IMPLICATIONS OF THE ECOTYPES OF ESTUARINE CRUSTACEA ...Classical, Estuaries, Invertebrate Anatomy, Isopods, Productivity - Food Chain, ...5.0418

INTESTINAL ADSORPTION AND TRANSPORT OF NUTRIENTS IN ECHINODERANS ...Active Transport, Cellular Or Intracellular, Echinodermata -other, Intestine, Sodium, ...5.0619

MORPHOLOGIC REGULATORY MECHANISMS IN TERRESTRIAL AND MARINE ORGANISMS ...Amphibia -non-specific & Other, Collagen, Developmental Physiology, Fish - other, Porifera, ...5.0982

FERTILIZATION MECHANISMS AND GAMETE PHYSIOLOGY IN MARINE INVERTEBRATES ...Basic Embryology, Male Gametes, Reproductive System, Sea Urchins & Other Echinoderm, ...5.0590

METABOLISM OF MARINE ECOSYSTEMS ...Energy Budgets, Food Webs, Other, Plankton (non-specific), Productivity - Food Chain, ...5.0966

BIOSYNTHESIS OF BROMOPHENOLS IN MARINE INVERTEBRATES ...Acorn Worms, Bioluminescence, Phenols, ...5.0961

METABOLISM OF COMPLETE WATER COLUMNS ...Antarctic Ocean, Autotrophic, Energy Budgets, Respiration, ...5.0967

BENTHIC COMMUNITIES ...Behavioral Ecology, Benthic Fauna, Bottom Sampling Device, Developmental Physiology, Fouling, Productivity - Food Chain, ...5.0561

CARBON DIOXIDE FIXATION IN HETEROTROPHIC ORGANISMS III THE BREAKDOWN OF GLYCOGEN IN MARINE INVERTEBRATES ...Alanine, Carbon Dioxide Fixation, Catabolism and Degradation, Glycogen, Oxygen, ...5.1033

PHYSIOLOGY AND ECOLOGY OF THE ADRIATIC BENTHOS ...Adriatic Sea, Benthic Organisms (non-specif), Marine Biology (non-specific), Microclimate-general, Productivity - Food Chain, ...5.0873

NITROGEN METABOLISM IN MOLLUSCS ...Biochemical, Evolutionary Studies-general, Gastropods -slugs,conch,snails, Metabolism (intracellular), Nitrogen, ...5.0506

SYMBIOSIS OF TROPICAL ZOANTHIDEA AND ZOOXANTHELLAE ...Anthozoa, Messenger RNA , Symbiosis, Tropic, Zooxanthella, ...5.0642

DEMINERALIZATION-BORING MECHANISMS OF MOLLUSKS ...Calcification, Gastropods -slugs,conch,snails, Invertebrate Anatomy, Invertebrate Physiology, ...5.0459

PHYSIOLOGICAL VARIATION AND ECOLOGY OF MOLLUSCS ...Energy Budgets, Gastropods -slugs,conch,snails, Population Dynamics, Reproductive System, Respiratory System, ...5.0472

UPTAKE OF ORGANIC COMPOUNDS BY MARINE INVERTEBRATES ...Amino Acids, Amino Acids -non-specific, Chemoreceptors, Invertebrate Nutrition, Invertebrates -non-specific, Marine Biology, Pulse-labelling, ...5.0938

MARINE ANIMAL USE IN THE STUDY OF HEALTH PROBLEMS ...Hormones, Hormones - Other, Life History Studies, ...6.0126

PROTEIN SYNTHESIS ACTIVATION IN SEA URCHIN EGGS ...Basic Embryology, Biosynthesis, Proteins, Reproductive System, Sea Urchins & Other Echinoderm, ...5.0543

INITIATION OF METAMORPHOSIS IN AURELIA ...Biological Rhythms, Growth Rate, Jelly Fish, Low Temp. -but Above 32f, Water Light Quality & Quantity, ...5.0599

Musculoskeletal System

FINE STRUCTURE OF JELLYFISH (CHRYSAORA QUINQUICERA) TENTACLE MUSCLE ...Contraction and Relaxation, Invertebrate Physiology, Jelly Fish, Microscopy - other, Skin Or Ectoderm, ...5.0659

COMPARATIVE MORPHOLOGY OF MARINE NEMATODES ...Comparative Physiology, Histology and Cytology, Invertebrate Anatomy, Nematoda -other, ...5.0567

REGULATION OF IONIC CONSTITUTENTS OF PROTOPLASM ...Active Transport, Dermal, Ions (inorganic), Nervous System, Osmoregulation, ...5.0970

STUDIES IN MICRONEUROPHYSIOLOGY ...Barnacles, Brain, Contraction and Relaxation, Gastropods -slugs,conch,snails, ...5.0362

EXCITATION-CONTRACTION COUPLING IN MUSCLE ...Contraction and Relaxation, Crabs, Lobsters, Plasma Membrane, ...5.0438

Nervous System

NEUROPHYSIOLOGICAL INVESTIGATIONS OF LIMULUS CENTRAL NERVOUS SYSTEM ...Brain, Cardiovascular, Horseshoe Or King Crabs, ...5.0469

GROWTH, DIFFERENTIATION AND NERVE TRANSMISSION IN THE HYDROID, CAMPANULARIA ...Basic Embryology, Developmental Physiology, Growth Rate, Hydra, Portuguese Man-of-war, ...5.0601

A HISTOCHEMICAL STUDY OF THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Cholinesterase, Histochemistry - Cytochem, Horseshoe Or King Crabs, Organelle-enzyme Assn, ...5.1000

IONIC PERMEABILITIES OF THE SQUID GIANT AXON. - EFFECTS OF CHEMICAL AGENTS ...Cellular Physiology, Microelectrodes, Octopus, Squid, Cuttlefish... , Permeability, ...5.0979

REGULATION OF IONIC CONSTITUTENTS OF PROTOPLASM ...Active Transport, Dermal, Ions (inorganic), Musculoskeletal System, Osmoregulation, ...5.0970

PHYSIOLOGY OF THE LIMULUS HEART ...Biological Rhythms, Cardiovascular, Heart, Horseshoe Or King Crabs, ...5.0463

MECHANISMS OF VENTILATORY CONTROL ...Crabs, Invertebrate Physiology, Respiratory System, ...5.0471

STRUCTURE AND FUNCTION OF EYES ...Vertebrate Anatomy, Visual Organs, ...5.0379

CONDUCTION AND INTEGRATION ...Behavior, Cellular Physiology, Hydra, Portuguese Man-of-war, Katydids, Musculoskeletal System, ...5.1018

ION TRANSPORT MECHANISM IN GIANT AXON ...Active Transport, Atpase, Cell Free Metabolism, Octopus, Squid, Cuttlefish... , Plasma Membrane, ...5.0369

LABORATORY OF NEUROBIOLOGY ...Facilities, Puerto Rico, ...12.0044

BIOCHEMICAL CHARACTERIZATION OF CHOLINESTERASES IN THE BLOOD ANDCENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Blood and Lymph, Cholinesterase, Enzyme-substrate, Horseshoe Or King Crabs, Reaction Rates, ...5.0468

Brain

NEUROPHYSIOLOGICAL INVESTIGATIONS OF LIMULUS CENTRAL NERVOUS SYSTEM ...Cardiovascular, Horseshoe Or King Crabs, Nervous System, ...5.0469

THE EFFECT OF SOME NEUROTRAMSMITTERS ON THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Cardiovascular, Horseshoe Or King Crabs, Nerve Effects, Neuroeffective, ...5.0470

ECOLOGICAL, EXPERIMENTAL AND COMPUTER STUDIES OF ENDOGENOUS RHYTHMICITY ...Biological Rhythms, Computer Methods -general, Crustacea -non-specific, Locomotion, ...5.0361

NEUROENDOCRINE REGULATION ...Crustacea -non-specific, Endocrine System, Osmoregulation, Sodium, Water, ...5.0426

STUDIES IN MICRONEUROPHYSIOLOGY ...Barnacles, Contraction and Relaxation, Gastropods -slugs,conch,snails, Musculoskeletal System, ...5.0362

STUDIES ON INTEGRATIVE MECHANISMS OF NEURONS ...Central Nervous System, Mathematical Biophysic, Visual Organs, ...5.0635

NEURAL MECHANISMS OF LEARNING AND BEHAVIOR ...Behavior, Gastropods -slugs,conch,snails, Learning and Retention, Mech of Transmission, ...5.0485

Osmoregulation

IONIC REGULATION IN THE QUEEN CONCH, STROMBUS GIGAS LINNAEUS ...Blood Plasma and Serum, Digestive System, Gastropods -slugs,conch,snails, ...5.0407

WATER AND SALT REGULATION IN NEREID POLYCHAETES ...Active Transport, Comparative Physiology, Lugworms, Marine Segmentedworm, Salt, ...5.0648

NEUROENDOCRINE REGULATION ...Brain, Crustacea -non-specific, Endocrine System, Sodium, Water, ...5.0426

NEUROENDOCRINE PATHWAYS IN OSMOREGULATION IN CRUSTACEANS ...Aquatic Ecology, Crabs, Endocrine System, Environmental Physiology, Shrimps - Common, ...5.0427

SURVIVAL REQUIREMENTS OF JUVENILE AND ADULT BLUE CRABS ...Biological Rhythms, Crabs, Environmental Physiology, Maturity & Growth Stages, Salinity, Size, ...5.0475

ULTRASTRUCTURE OF CELL ION TRANSPORT MECHANISMS ...Active Transport, Electron Microscopy, Mitochondrial Membranes, Nutrition and Metabolism, Respiratory System, ...5.0974

REGULATION OF IONIC CONSTITUTENTS OF PROTOPLASM ...Active Transport, Dermal, Ions (inorganic), Musculoskeletal System, Nervous System, ...5.0970

OPERANT OSMOTIC REGULATION IN A MARINE ANIMAL ...Environment Resistance, Learning and Retention, Octopus, Squid, Cuttlefish... , Water Salinity, ...5.0664

Regeneration and Wound

STUDIES ON GAMETOGENESIS IN HYDROMEDUSAE ...Basic Embryology, Developmental Physiology, Differentiation Mechanism, Hydra, Portuguese Man-of-war, Reproductive System, Testosterone, ...5.1040

CORRELATION BETWEEN ELECTRICAL PATTERNS AND MORPHOGENETIC PATTERNS DURING REGENERATION ...Developmental Physiology, Electrical Fields, Hydra, Portuguese Man-of-war, ...5.0602

Reproductive System

COLUMBIA RIVER STUDIES ...Columbia River, Contamination - Water, Invertebrates, Oysters, Pollution Effects, Radioactivity-general, ...5.0518

BIOLOGY-MIDDLE EAST WATERS ...Cell Cycle, Marine Biology (non-specific), Middle-east-general, Phenology, Red Sea, Synchronization, ...5.0929

BIOCHEMISTRY OF FERTILIZATION AND EARLY DEVELOPMENT ...Basic Embryology, Fertilization, Sea Urchins & Other Echinoderm, Vertebrates -non-specific, ...5.0550

MACROMOLECULAR EVENTS OF FERTILIZATION AND EARLY EMBRYONIC DEVELOPMENT ...Basic Embryology, Biosynthesis, Ribosomes, Sea Urchins & Other Echinoderm, ...5.1011

RELATIONSHIPS AMONG POPULATIONS OF LIMNORIA TRIPUNCTATA ...Animal Taxonomy, Isopods, Population Dynamics, ...5.0477

PHYSIOLOGY OF FERTILIZATION AND NUCLEO-CYTOPLASMIC INTERACTIONS IN SEA URCHIN DEVELOPMENT ...Basic Embryology, Messenger RNA , Nucleus (non-specific & Ot.), Sea Urchins & Other Echinoderm, Selection & Breeding, ...5.0673

TEMPERATURE NEEDS FOR GONADAL DEVELOPMENT AND SPAWNING OF DIFFERENT PHYSIOLOGICAL RACES OF THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA ...Behavior, Biological Rhythms, Environmental Physiology, Oysters, Water Temperature-non-specific, ...5.0352

STUDIES ON GAMETOGENESIS IN HYDROMEDUSAE ...Basic Embryology, Developmental Physiology, Differentiation Mechanism, Hydra, Portuguese Man-of-war, Regeneration and Wound, Testosterone, ...5.1040

GAMETOGENESIS AND FERTILIZATION IN THE BLUE CRAB, CALLINECTES SAPIDUS RATHBUN, AND OTHER CRABS ...Crabs, Electron Microscopy, Histochemistry - Cytochem, Structural Functions, ...5.0478

FERTILIZATION MECHANISMS AND GAMETE PHYSIOLOGY IN MARINE INVERTEBRATES ...Basic Embryology, Male Gametes, Metabolism, Sea Urchins & Other Echinoderm, ...5.0590

EXPERIMENTAL STUDIES ON THE BIOLOGY AND FOOD CHAIN ECONOMICS OF THE CHAETOGNATHS ...Energy Budgets, Productivity - Food Chain, Whole Body Culture & Rearing, Zooplankton, ...5.0777

REPRODUCTIVE RELATIONSHIPS AMONG POPULATIONS OF A MARINE WOOD-BORING ISOPOD ...Animal Taxonomy, Invertebrate Anatomy, Isopods, Population Dynamics, ...5.0414

STUDIES ON EMBRYONIC CELLS ...Basic Embryology, Chickens, Sea Squirts - Tunicates, Suspension Culture, ...5.0945

REPRODUCTION AND EMBRYONIC SURVIVAL IN ASCIDIA NIGRA (SAVIGNY) ...Basic Embryology, Biological Rhythms, Laboratory, Sea Squirts - Tunicates, Whole Body Culture & Rearing, ...5.0600

NUCLEIC ACID AND PROTEIN SYNTHESIS DURING OOGENESIS ...Autoradiography, Basic Embryology, Gastropods -slugs,conch,snails, Gene Action, Lugworms, Marine Segmentedworm, ...5.1024

LIFE HISTORY AND DEVELOPMENT OF POLYCHAETOUS ANNELID LARVAE ...Behavior, Developmental Physiology, Life History Studies, Lugworms, Marine Segmentedworm, Whole Body Culture & Rearing, ...5.0604

POLYCHAETES AND ECHINODERMS IN THE LABRADOR SEA ...Animal Taxonomy, Brittle Stars, Labrador Sea, Lugworms, Marine Segmentedworm, Starfishes, ...5.0603

KODIAK KING CRAB ENVIRONMENTAL ZONE SURVEY ...Alaska, Continental Shelf, Environmental Ecology, Horseshoe Or King Crabs, ...5.0348

ISOLATION AND FUNCTION OF OVARIAN EXTRACTS CAPABLE OF INDUCING COCYTE SHEDDING AND OCYTE NUCLEAR MATURATION IN STARFISH ...Differentiation Mechanism, Female, Hormones, Nucleic Acids, Starfishes, ...5.0620

REPRODUCTIVE BIOLOGY, DEVELOPMENT, AND SYSTEMATICS OF THE SIPUNCULIDS OF THE CARIBBEAN ...Animal Taxonomy, Caribbean Sea, Developmental Physiology, Invertebrates -non-specific, Range Or Territorial Distr. , ...5.0579

ECOLOGICAL FACTORS AFFECTING REPRODUCTION OF SHELLFISH (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...Animal Distr. (non-specific), Maturity & Growth Stages, New York, Oysters, Spawning & Nesting Sites, ...5.0374

EARLY LIFE HISTORY DECAPOD CRUSTACEANS ...Animal Distr. (non-specific), Crabs, Environmental Ecology, Life History Studies, Shrimps - Common, ...5.0343

DIAGNOSTIC CHARACTERS & DEVELOPMENT OF EXTERNAL GENITALIA IN JUVENILE GROOVED SHRIMPS OF GENUS PENAEUS FROM WESTERN ATLANTIC ...Atlantic Ocean-general, Developmental Physiology, Invertebrate Anatomy, Shrimps - Common, ...5.0405

SELECTIVE BREEDING OF THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA (GENETICS OF SHELLFISH PROGRAM) ...Karyotypes, Morphological Action, Mutagens, Oysters, Selection & Breeding, ...5.0376

SURF CLAM BIOLOGY ...Age, Clams, Growth Rate, Life History Studies, Tags, ...5.0449

PHYSIOLOGICAL VARIATION AND ECOLOGY OF MOLLUSCS ...Energy Budgets, Gastropods -slugs,conch,snails, Metabolism, Population Dynamics, Respiratory System, ...5.0472

NUTRIENT STORES IN REPRODUCTION IN SEA INVERTEBRATES ...Crabs, Decapoda -other, Invertebrate Nutrition, Starfishes, ...5.0949

PROTEIN SYNTHESIS ACTIVATION IN SEA URCHIN EGGS ...Basic Embryology, Biosynthesis, Metabolism, Proteins, Sea Urchins & Other Echinoderm, ...5.0543

Respiratory System

ULTRASTRUCTURE OF CELL ION TRANSPORT MECHANISMS ...Active Transport, Electron Microscopy, Mitochondrial Membranes, Nutrition and Metabolism, Osmoregulation, ...5.0974

PHYSIOLOGICAL VARIATION AND ECOLOGY OF MOLLUSCS ...Energy Budgets, Gastropods -slugs,conch,snails, Metabolism, Population Dynamics, Reproductive System, ...5.0472

MECHANISMS OF VENTILATORY CONTROL ...Crabs, Invertebrate Physiology, Nervous System, ...5.0471

Other

METABOLISM OF MARINE ECOSYSTEMS ...Energy Budgets, Food Webs, Metabolism, Plankton (non-specific), Productivity - Food Chain, ...5.0966

Sensory Organs

Auditory

VISUAL AND ACOUSTICAL COMMUNICATION IN CERTAIN MARINE CRUSTACEANS ...Atlantic Ocean-north, Behavior, Crabs, Visual Organs, ...**5.0430**

Chemoreceptors

UPTAKE OF ORGANIC COMPOUNDS BY MARINE INVERTEBRATES ...Amino Acids, Amino Acids -non-specific, Invertebrate Nutrition, Invertebrates -non-specific, Marine Biology, Metabolism, Pulse-labelling, ...**5.0938**

Proprioceptors

STATOLITH DIFFERENTIATION IN AURELIA (JELLYFISH) ...Calcium, Developmental Physiology, Differentiation Mechanism, Jelly Fish, ...**5.0598**

NEUROPHYSIOLOGICAL MECHANISMS IN BEHAVIOR ...Giant Water Bug, Water Strider, Horseshoe Or King Crabs, Locomotion, ...**5.0490**

Visual Organs

VISUAL AND ACOUSTICAL COMMUNICATION IN CERTAIN MARINE CRUSTACEANS ...Atlantic Ocean-north, Auditory, Behavior, Crabs, ...**5.0430**

RESEARCH ON THE BIO-SYSTEMATICS OF THE CIRRIPEDIA ...Barnacles, Biological Rhythms, Developmental Physiology, ...**5.0364**

PHYSIOLOGY OF LUMINESCENT SIGNAL SYSTEMS ...Bioluminescence, Photoreception, Trace Elements, ...**5.0950**

CEPHALOPOD LENS DEVELOPMENT ...Basic Embryology, Differentiation Mechanism, Lens Proteins, Microtubules, Octopus, Squid, Cuttlefish... , ...**5.0424**

THE STRUCTURE AND FUNCTION OF CRUSTACEAN EYES ...Crustacea -non-specific, Invertebrate Anatomy, Light -other, Oceanic - Pelagic, Vertical Distribution, ...**5.0363**

STRUCTURE AND FUNCTION OF EYES ...Vertebrate Anatomy, ...**5.0379**

Skin Or Ectoderm

FINE STRUCTURE OF JELLYFISH (CHRYSAORA QUINQUICERA) TENTACLE MUSCLE ...Contraction and Relaxation, Invertebrate Physiology, Jelly Fish, Microscopy - other, Musculoskeletal System, ...**5.0659**

Cilia and Flagellae

A COMPARATIVE SYSTEMATIC INVESTIGATION OF MARINE CILIATES IN THE HOLOTRICHOUS PROTOZOAN ORDER HYMENOSTOMATIDA ...Animal Taxonomy, Ciliates, Comparative Physiology, Invertebrate Anatomy, ...**5.0840**

Derivatives

HISTOCHEMICAL STUDIES OF MUCOSUBSTANCES IN THE MANTLE OF THE NORTHERN QUAHOG, MERCENARIA MERCENARIA ...Calcification, Clams, Histochemistry - Cytochem, Mucopolysaccharides, Mucoproteins, ...**5.0455**

CONTINUED STUDIES OF THE SYSTEMATICS AND ZOOGEOGRAPHY OF WESTERN ATLANTIC CAECIDAE ...Animal Taxonomy, Atlantic Ocean-general, Gastropods - slugs,conch,snails, Invertebrate Anatomy, Pubilications -other, ...**5.0696**

CYTOTAXONOMY OF SPECIES OF RELATED PELECYPOD MOLLUSKS ...Animal Taxonomy, Clams, Invertebrate Anatomy, Oysters, Selection & Breeding, ...**5.0413**

ECOLOGY OF PLANKTONIC FORAMINIFERA AND RELATED STUDIES ...Flagellates, Foraminifera, Gastropods - slugs,conch,snails, Plankton Sampling, Vertical Distribution, ...**5.0812**

POPULATION GENETICS AND LARVAL ECOLOGY OF HAWAIIAN LITTORINA ...Gastropods -slugs,conch,snails, Hawaii, Maturity & Growth Stages, Polymorphism, ...**5.0429**

MECHANISMS OF CALCIUM CARBONATE DEPOSITION ...Barnacles, Biogeochemical Process, Calcium, Chemical Reactions, Fouling, ...**5.1015**

PURCHASE OF MATERIALS FOR & CONSTRUCTION OF, FLOATS, RACKS, BAGS, AND TRAYS FOR THE SUSPENSION OF VARIOUS TYPES OF CULTCH ...Biological Rhythms, Equipment Purchase Operation, Oysters, Spawning & Nesting Sites, Stocking of Fish & Shellfish, ...**8.0008**

THE PROCESS OF DEMINERALIZATION-BORING IN BIVALVES ...Calcification, Freshwater Mussels, Scallops, Invertebrate Anatomy, Invertebrate Physiology, ...**5.0366**

Tissues

STUDIES IN OYSTER PATHOLOGY ...Invertebrate Pathology, Mortality Rates, Oysters, Pathology, ...**5.0519**

TISSUE CULTURE - VIROLOGY ...Animal Viruses (non-specific), Bacteria (non-specific), Cell Injury and Autolysis, Marine Biology, Monolayer Culture, Oysters, ...**5.0978**

Venom

CHARACTERIZATION AND MODE OF ACTION OF PROTEIN VENOMS OF MARINE ANIMALS ...Lecithin, Mechanism of Action, Sea Urchins & Other Echinoderm, Toxicology, Toxins, ...**6.0102**

ACTIONS OF BIO-TOXINS ON CELL MEMBRANES ...Muscle, Nervous System, Plasma Membrane, ...**6.0128**

Whole Body Culture & Rearing

EXPERIMENTAL STUDIES ON THE BIOLOGY AND FOOD CHAIN ECONOMICS OF THE CHAETOGNATHS ...Energy Budgets, Productivity - Food Chain, Reproductive System, Zooplankton, ...**5.0777**

REPRODUCTION AND EMBRYONIC SURVIVAL IN ASCIDIA NIGRA (SAVIGNY) ...Basic Embryology, Biological Rhythms, Laboratory, Reproductive System, Sea Squirts - Tunicates, ...**5.0600**

LIFE HISTORY AND DEVELOPMENT OF POLYCHAETOUS ANNELID LARVAE ...Behavior, Developmental Physiology, Life History Studies, Lugworms, Marine Segmentedworm, Reproductive System, ...**5.0604**

LIFE HISTORY OF THE SHARK COPEPOD, KROYERIA DISPAR ...Copepods, Developmental Physiology, Ectoparasites, Life History Studies, ...**5.0393**

REARING AND SENSITIVITY STUDIES OF VARIOUS LIFE STAGES OF MARINE MACROINVERTEBRATES ...Bioindicators, Crabs, Shrimps - Common, ...**5.0496**

Invertebrates -non-specific

STUDIES ON THE STRUCTURE OF HEMERYTHRIN ...Biochemical, Comparative Physiology, Configuration, Hemerythrin, ...**5.0993**

UPTAKE AND ASSIMILATION OF ORGANIC COMPOUNDS IN MARINE ORGANISMS ...Active Transport, Metabolism, Nutrition, Organics, Productivity - Food Chain, ...**5.0937**

SUPPORT OF TRAINING PROGRAMS IN INVERTEBRATE ZOOLOGY AND MARINE BOTANY ...Marine Biology, Marine Environments-general, Marine Plants, Meetings, Training Grants, Fellowships, ...**11.0028**

ORGANIZATION OF THE ACADEMYS COLLECTION OF RECENT MARINE, TERRESTRIAL, AND FRESHWATER INVERTEBRATES ...Animal Taxonomy, Collections, ...**5.0752**

RESEARCH TRAINING IN MARINE BIOLOGY, PALEONTOLOGY AND SYSTEMATIC ZOOLOGY ...Animal Taxonomy, Oceanography-general, Paleontology, Training Grants, Fellowships, ...**11.0003**

STUDENT RESEARCH AT THE MARINE SCIENCE CENTER ...Facilities, Intertidal Areas, Invertebrate Physiology, Oregon, Training Grants, Fellowships, ...**11.0039**

COOPERATIVE SYSTEMATICS STUDIES IN ANTARCTIC BIOLOGY ...Animal Taxonomy, Antarctica, Cooperative-studies, Equipment Purchase Operation, ...**5.0581**

MARINE ECOLOGICAL STUDIES ...Environmental Ecology, Habitat Studies, Intertidal Areas, Stress, ...**5.0917**

REFERENCE COLLECTION OF GULF MARINE ANIMALS ...Animal Taxonomy, Collections, Gulf of Mexico, Vertebrates - non-specific, ...**5.0657**

PHYSIOLOGICAL VARIATION IN SUBTIDAL AND INTERTIDAL MARINE INVERTEBRATES ...Habitat Studies, Intertidal Areas, ...**5.0548**

ALGAE AS FOOD FOR MARINE INVERTEBRATE LARVAE HELD IN THE LABORATORY ...Algal Culture, Bulk Culture -other, Chesapeake Bay, Invertebrate Nutrition, ...**5.0732**

ECOLOGY OF PANAMANIAN REEF COMMUNITIES ...Behavioral Ecology, Panama, Productivity - Food Chain, Reefs, Tropic, ...**5.0866**

THE BIOLOGY OF ROCK-BORING SIPUNCULIDS ...Caribbean Sea, Invertebrate Nutrition, Invertebrate Physiology, Reefs, ...**5.0577**

SYSTEMATICS OF ANTARCTIC SIPUNCULIDS AND ECHIURIDS COLLECTED BY THE ELTANIN EXPEDITION ...Animal Taxonomy, Antarctica, Collections, Expeditions, ...**5.0578**

REPRODUCTIVE BIOLOGY, DEVELOPMENT, AND SYSTEMATICS OF THE SIPUNCULIDS OF THE CARIBBEAN ...Animal Taxonomy, Caribbean Sea, Developmental Physiology, Range Or Territorial Distr. , Reproductive System, ...**5.0579**

SYSTEMATICS AND MORPHOLOGY OF THE SIPUNCULID LARVAE OF THE INDIAN OCEAN ...Animal Taxonomy, Developmental Physiology, Indian Ocean-general, Invertebrate Anatomy, ...**5.0765**

EXPLORATORY COLLECTION AND CARE OF AQUATIC INVERTEBRATES FOR TESTING AT TIBURON ...Bioassay, Brackish Water, Captive Rearing, Pesticides -non-specific, ...**5.0905**

THERMAL PREFERENCES OF MARINE FISHES AND INVERTEBRATES ...Behavior, Fish -non-specific, Thermal, Water Temperature-non-specific, ...**5.0209**

UPTAKE OF ORGANIC COMPOUNDS BY MARINE INVERTEBRATES ...Amino Acids, Amino Acids -non-specific, Chemoreceptors, Invertebrate Nutrition, Marine Biology, Metabolism, Pulse-labelling, ...**5.0938**

Ion Exchange

TRACE ELEMENT EQUILIBRIUM STUDIES ...Adsorption, Chelating Agents, Material Recovery, Trace Elements, Tracers, ...**1.0088**

Iron

NUCLEAR CHEMISTRY AND GEOCHEMISTRY RESEARCH ...Nuclear - General, ...**7.0082**

MICROBES AND CORROSION ...Cathodic Protection, Extracellular-enzymes, Fouling, Metals -non-specific, Microorganisms (non-specific), Respiration, ...**8.0228**

INTERACTIONS OF MARINE NUTRIENT COMPLEXES ...Marine Plants, Nutrients, Phosphorus, Phytoplankton, Tracers, ...**5.0956**

Isotope Tracer

Isotope Dilution

NUCLEAR OCEANOGRAPHIC TECHNIQUES ...Currents-ocean, Physical Properties, Radioactivity, Water Analysis, Water Motion Recorders, ...**8.0087**

MEASUREMENT OF COMMON LEAD IN THE EARTHS HYDROSPHERE ...Atomic Absorption, Composition, Greenland, Lead, Other Sources, ...**3.0069**

Isotope Tracer-other

TRACE ELEMENTS IN SEA WATER ...Activation Analysis, Long Island Sound, Radioactivity-general, Trace Element Analysis, ...**1.0085**

GEOCHEMICAL STUDIES OF CONTINENTAL WATERS ...Authigenesis, Element Ratios, Geochemical Analysis, Isotope, Location, Pore Fluids, Radioisotopes, Water Analysis, ...**1.0121**

LIGHT ISOTOPE STUDIES ...Chemical Reactions, Circulation-general, Deuterium, Mixing, Oxygen, Particle-gas Transfer, ...**1.0077**

CHEMICAL OCEANOGRAPHY ...Arctic, Circulation-general, Oceanic Fronts, Tracers, Water Analysis-general, ...**1.0072**

UTILIZATION OF RADIOACTIVE TRACERS IN BEACH STUDIES ...Fluorometry, Tracers, ...**7.0218**

EFFECT OF NITRILOTRIACETIC ACID (NTA) UPON THE TOXICITY OF METALS TO SELECTED SPECIES OF ESTUARINE PHYTOPLANKTON ...Acids, Carbon, Chemicals (incl. algacides), Estuaries, Phytoplankton, ...**5.0829**

Isotopes

Isotopes -non-specific

BIOLOGICAL INVESTIGATIONS WITH ISOTOPES ...Algae-General, Facilities, Marine Plants, Radiation Effects-non-specific, Radioecology, ...**11.0025**

Radioactive Isotopes

Carbon

C-14 UPTAKE, LIMITING FACTORS AND EXCRETION PRODUCTS OF ANTARCTIC PHYTOPLANKTON ...Antarctic Ocean, Phytoplankton, Primary Productivity, Secretions and Products, ...**5.0813**

MEASUREMENT OF THE RATE OF CARBON DIOXIDE (C14) FIXATION INTO SUBCELLULAR FRACTIONS OF ALGAE ...Algae- General, Algal Culture, Bioindicators, Carbon Dioxide Fixation, Growth Rate, Intracellular Localization, ...**5.0728**

Mercury

RADIOCHEMICAL TECHNIQUES ...Food Spoilage Detection, Polonium, Radioactive Isotopes, Smoking, Wheat, ...**6.0008**

Polonium

RADIOCHEMICAL TECHNIQUES ...Food Spoilage Detection, Mercury, Radioactive Isotopes, Smoking, Wheat, ...**6.0008**

Radioisotopes -non-specific

STUDIES ON THE PHYSIOLOGY OF MARINE ORGANISMS USING RADIOISOTOPES ...Equipment Purchase Operation, Facilities, Marine Plants, ...**12.0031**

Italy

THE OSTRACODA OF THE BAY OF NAPLES ...Environmental Ecology, Invertebrate Anatomy, Life History Studies, Nomenclature, Classification, Shrimps - Seed Or Mussel, ...**5.0415**

AMERICAN TABLES COMMITTEE FOR THE NAPLES ZOOLOGICAL STATION ...Facilities, ...**11.0008**

Jamaica

PHYSICAL AND BIOLOGICAL OCEANOGRAPHY OF A LUMINOUS BAY ...Bays, Bioluminescence, Circulation-general, Model Studies, Phytoplankton, ...**5.0976**

BIOLUMINESCENCE ...Autotrophic, Bays, Bioluminescence, Phytoplankton, Responses to Growth, ...**1.0165**

SYSTEMATIC STUDIES OF SPONGES OF THE JAMAICAN FORE-REEF SLOPE ...Animal Taxonomy, Habitat Studies, Invertebrate Anatomy, Porifera, Reefs, ...**5.0558**

ISOTOPIC AND CHEMICAL COMPOSITION OF ORGANIC CARBONATES ...Biochemical, Chemical, Organic Limestone, Reefs, Sedimentary Petrogenesis, ...**7.0084**

Japan

GEOPHYSICAL INVESTIGATIONS OF THE SOUTHWEST MARGIN OF JAPAN ...Distribution, Ocean Basins, Regional Structure, Ships and Cruises, Trenches, ...**7.0045**

INSPECTION OF OYSTER SEED - NEW ASIATIC SOURCES ...Captive Rearing, Commercial Fishing, Germ Free Animal, Oysters, ...**5.0511**

MARINE BIOLOGICAL INVESTIGATIONS - JAPANESE FISHERY OBSERVERS PROJECT ...Commercial Fishing, Gulf of Alaska, Nets, Righteye Flounders, ...**5.0012**

ANALYSIS OF JAPANESE CATCH STATISTICS ...Commercial Fishing, Number Or Density, Pacific Ocean-north, Salmon - coho,chinook,sockeye.., ...**5.0166**

Jelly Fish

PHYSALIA TOXIN AND THE ACTIVITY OF BIOLOGICAL MEMBRANES ...Active Transport, Animal Toxins, Cellular Membranes (non-spec.), Toxicology, ...**6.0107**

ENHANCEMENT OF RECREATIONAL USES OF ESTUARINE WATERS THROUGH STUDY OF POTENTIAL CONTROL METHODS FOR STINGING SEA NETTLES ...Biological Control, Chesapeake Bay, Estuaries, Recreation Sites, Water Quality-general, ...**5.0605**

FINE STRUCTURE OF JELLYFISH (CHRYSAORA QUINQUICERA) TENTACLE MUSCLE ...Contraction and Relaxation, Invertebrate Physiology, Microscopy -other, Musculoskeletal System, Skin Or Ectoderm, ...**5.0659**

STATOLITH DIFFERENTIATION IN AURELIA (JELLYFISH) ...Calcium, Developmental Physiology, Differentiation Mechanism, Proprioceptors, ...**5.0598**

INITIATION OF METAMORPHOSIS IN AURELIA ...Biological Rhythms, Growth Rate, Low Temp. -but Above 32f, Metabolism, Water Light Quality & Quantity, ...**5.0599**

Joining and Assembling

Welding

Inert Gas

UNDERWATER WELDING ...Helium, Materials Used Undersea, Safety, Scientific-service-support, Subsurface Environments, ...**8.0344**

Joining and Assembling

Process Control

STRUCTURAL DESIGN CRITERIA ...Flaw Detection - Other, Hull, Hydrodynamic Structures, Safety, Stress Concentration-toughness, ...8.0283

Welding - Other

DEEP SUBMERGENCE SYSTEMS ...Buoyant, Flotational, Geomorphology-topography, Marine Propulsion, Navigation Communication, Physical Properties, Submersibles, ...8.0051

HY 130-150 STRUCTURAL STEELS ...High Yield, Low Alloy Steels - Other, Materials Used Undersea, Stress Concentration-toughness, Stress Corrosion, ...8.0221

HY 80-110 STRUCTURAL STEELS ...High Yield, Materials Used Undersea, Stress Concentration-toughness, ...8.0222

HY 180/210 STRUCTURAL STEELS ...High Yield, Low Alloy Steels - Other, Maraging, Materials Used Undersea, Precipitation Hardening, Stress Concentration-toughness, ...8.0224

Korea

METABOLIC ADAPTATION TO COLD ...Cold, Female, Hypothermia, Metabolism in Disease, Regulation, ...6.0092

Laboratory Analysis

RESEARCH ON TURBULENT CONVECTION ...Convection, Forced Convection, Stratified, Turbulence, Turbulent, ...2.0058

ELECTROKINETIC SOIL STUDY ...Buried Structures, Electro-osmosis, Electroosmosis, Electrophoresis, Marine Soils, Stabilization, ...8.0342

MARINE HYDRODYNAMICS ...Antarctic Ocean, Circulation-general, Model Studies, Waves, Waves-internal, ...8.0196

DYNAMICS OF MOORED BUOY SYSTEMS USED IN OCEANOGRAPHY R&D AND SURVEILLANCE ...Buoys, Currents-ocean, Model Studies, Moorings, Waves, ...8.0321

EXPERIMENTAL AND THEORETICAL RESEARCH ON TURBIDITY CURRENTS ...Currents-other, Hydraulic Structures, Sedimentation, ...7.0243

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UTILIZATION OF PHYSICAL AND MATHEMATICAL MODELS IN MARINE WATER RESOURCES RESEARCH AND MANAGEMENT ...Environmental Effects-geologic, Estuaries, Mathematical Analysis, Model Studies, Shoreline - Coastline, ...**4.0084**

TIDE MARSH ECOLOGY AND WILDLIFE ...Microorganisms (non-specific), Nitrogen Cycle, Nutrients, Phosphorus, Primary Productivity, Swamps-marshes, ...**5.0870**

CULTURE OF ATLANTIC CROAKER IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Brackish Water, Captive Rearing, Drums, Ponds, Productivity (agricultural), ...**8.0005**

PROJECT AQUA-MAP - DEVELOPMENT OF AERIAL PHOTOGRAPHY AS AN AID TO WATER QUALITY MANAGEMENT ...Aerial Photography, Effluents-waste Water, Model Studies, New York, Pollutants-other, ...**4.0167**

THE EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ON BEEF CATTLE PRODUCTION, PLANT ECOLOGY, SOIL PRODUCTIVITY, AND ESTUARINE ANIMALS ...Cultural Control of Insects, Ectoparasitic Insects, Wetlands, ...**5.0927**

SPACECRAFT OCEANOGRAPHY ...Instrumentation, Instrumentation-general, Photography, Satellites, Unmanned Satelite, ...**4.0157**

FLOW AND SALINITY IN THE HUDSON ESTUARY, NEW YORK ...Estuaries, Fresh Water, Inflow, Salinity, Tides, ...**2.0075**

TECHNIQUES OF PLANNING ...Application, Control Systems, Mathematical Analysis, Operations Research, Planning, Southern, Systems Analysis, ...**9.0017**

Manganese

DEPOSITION RATES BY THE PROTACTINIUM METHOD ...Chemical, Distribution, Element Ratios, Sedimentary Petrogenesis, Thermal, Thorium, Uranium, ...**7.0270**

STRUCTURE, MINERALOGY, AND CHEMICAL COMPOSITION OF MARINE MANGANESE NODULES ...Chemistry, Mineralogy, Origin, Polished Sections, Precipitates, Textures-structures, ...**7.0028**

CATALYSIS AND KINETICS OF MANGANOUS ION OXIDATION IN AQUEOUS SOLUTION AND ADSORBED ON THE SURFACES OF SOLID OXIDES ...Adsorption, Heterogeneous Catalysis, Oxidation-other, Oxide, Precipitates, Solution, ...**2.0063**

Manometers

GROWTH AND CELLULAR MORPHOGENESIS IN NITELLA ...Elongation of Cell, Growth and Differentiation, Nitella, Plant Developmental Biology, Water Movement, ...**5.0721**

Mapping

FEASIBILITY STUDY FOR SYNTHETIC APERTURE ARRAY ACOUSTIC BOTTOM MAPPING SYSTEM ...Acoustic, Charts, Doppler, Geomorphology-topography, ...**4.0061**

VISIBLE REGION INSTRUMENTATION FOR OCEANOGRAPHIC SATELLITES ...Currents-ocean, Geomorphology-topography, Photography, Satellites, Shoals, ...**8.0088**

MARINE GEOLOGY ...Acoustical, Bathymetry, Geomorphology-topography, Magnetic Studies, Sea Floor Spreading, ...**7.0041**

AIRBORNE SEA SURFACE MEASUREMENTS IN THE EQUATORIAL PACIFIC ...Atolls, Humidity, Infrared Radiation, Oceanic Fronts, Radiation Detection, Temperature, ...**1.0190**

SYSTEM DESIGN STUDY FOR THE U.S. NAVAL OCEANOGRAPHIC OFFICE INTELLIGENCE DATA HANDLING SYSTEM ...Data Analysis - General, Data Reduction and Analysis, Geophysics-general, Optimization Technique, Systems Analysis, ...**4.0016**

BIO-ACOUSTIC AND BIOLOGICAL SAMPLING GEAR STUDIES ...Acoustical, Indian Ocean-general, Organism Sampling Devices, Plankton (non-specific), ...**8.0126**

DEVELOPMENT OF A PHOTOGRAPHIC SUIT FOR STEREOPHOTOGRAMMETRIC MAPPING BY SUMBERSIBLE ...Navigation, Photography, Sonar, Submersibles, Turkey, ...**4.0060**

CIRCULATION IN THE GULF OF MEXICO ...Circulation-general, Currents-ocean, Gulf of Mexico, Infrared Radiation, Oceanic Fronts, ...**2.0022**

SEA ICE MOVEMENT DYNAMICS ...Charts, Forecasting-prediction, Model Studies, Polar, Sea Ice, ...**3.0087**

LOCATING AND MAPPING THE EXISTING SEED OYSTER BEDS IN DELAWARE BAY ...Aquatic Ecology, Bays, Delaware Bay, Oysters, Spawning & Nesting Sites, ...**5.0381**

EVALUATION AND STATISTICAL ANALYSIS OF ALL DATA ...Data Analysis - General, Geomorphology-topography, Spawning & Nesting Sites, Statistics-general, ...**4.0018**

OCEANOGRAPHY ATLAS OF THE NORTH CAROLINA CONTINENTAL MARGIN ...Atlases-maps, Continental Shelf, North Carolina, ...**4.0059**

GEOPHYSICAL SURVEYING AND CHARTING ...Airborne Gravimeters, Data Acquisition, Development of Models, Gravity Studies, Platforms, ...**7.0106**

DIVER-ASSISTED OCEANOGRAPHY ...Benthonic-bottom, Continental Shelf, Currents-bottom, Diving and Scuba, Geomorphology-topography, Waves-internal, ...**4.0098**

DEVELOPMENT OF OFFSHORE SOURCES OF SAND SUITABLE FOR BEACH RESTORATION AND NOURISHMENT ...Beach, Coring and Dredging, Ocean Mining, Shoreline Structures, Size, ...**7.0012**

TEKTITE I ...Diving and Scuba, Geologic Maps, Geology-general, Submersibles, ...**4.0054**

WESTERN PACIFIC ISLANDS ...Hawaii, Igneous Activity - Volcanism, Lava, Petrology, Sea Level Changes, ...**7.0104**

WORLD WIDE MARINE MINERAL RESOURCES ...Continental Shelf, Continental Slope, Economics, Potential of Deposit, Resource Inventories, ...**4.0056**

EASTERN TROPICAL PACIFIC COOPERATIVE SURVEY ...Bathythermographs, Pacific Ocean-east, Ships and Cruises, ...**4.0122**

Maps

Charts

FEASIBILITY STUDY FOR SYNTHETIC APERTURE ARRAY ACOUSTIC BOTTOM MAPPING SYSTEM ...Acoustic, Doppler, Geomorphology-topography, Mapping, ...**4.0061**

STRUCTURE OF OCEAN BASINS ...Basins, Bathymetry, Indian Ocean-general, Ridges, Structural Studies, ...**7.0092**

DATA COLLECTION ...Data Acquisition, Data Analysis - General, Instrumentation-general, Sampling, ...**4.0017**

SEA ICE MOVEMENT DYNAMICS ...Forecasting-prediction, Mapping, Model Studies, Polar, Sea Ice, ...**3.0087**

DISTRIBUTION MAPS OF ANTARCTIC HOLOTHURIANS AND ECHINOIDS - ECHINODERMAT ...Environmental Ecology, Sea Cucumber, Sea Urchins & Other Echinoderm, Vertical Distribution, ...**5.0573**

ANALYSIS AND DISPLAY OF HYDROGRAPHIC DATA ...Compilation, Hydrographic, Reproduction, ...**4.0022**

Geologic Maps

POTENTIALLY-ECONOMIC SAND AND SILT DEPOSITS IN LAKE ONTARIO, NEW YORK ...Lake Ontario, New York, Potential of Deposit, Sands and Gravels, Submergent, ...**7.0024**

SEDIMENT DISPERSAL PATTERNS IN SUBMARINE CANYONS AND SUBSEA FANS ...Distribution, Fans, North America, Submarine Canyons, Textures-structures, ...**7.0215**

TEKTITE I ...Diving and Scuba, Geology-general, Mapping, Submersibles, ...**4.0054**

CENTRAL CALIFORNIA CONTINENTAL MARGIN ...California, Continental Shelf, Continental Slope, San Andreas Fault, Structural Studies, ...**7.0036**

Gravity

GRAVITY ...Anomalies, Caribbean Sea, Geophysical Equipment, Navigation, Pacific Ocean-west, ...**7.0142**

Maps-general

ECOLOGICAL STUDIES OF THE COPPER RIVER DELTA ...Alaska, Censusing, Spawning & Nesting Sites, Waterfowl - non-specific, ...**5.0855**

Maps-other

MONTVILLE STATION TEMPERATURE SURVEY (THAMES RIVER) ...British Isles, Electric Power Plants, Estuaries, Temperature, Thermal Pollution, ...**1.0182**

A GLOBAL DIRECTORY OF TIDAL CONSTANTS ...Arcs, Tables, Compilations, Catalogs, Tides, ...**2.0079**

Paleocurrents

RELATION OF SEDIMENT STRUCTURES AND FLOW DIRECTIONS OF COASTAL CURRENTS ...Coastlines-shorelines, Current Bedding, Ocean Currents-other, Sedimentation, Textures-structures, ...**7.0276**

Reconnaissance

OREGON-NORTHERN CALIFORNIA PLACER DEPOSITS ...California, Deposits-ores, Drilling and Coring, Oregon, Placer, ...**7.0009**

Topographic

EXPERIMENTAL VERFICATION OF WIDE SWATH OCEAN BOTTOM CONTOURING WITH SPLIT BEAM RECEIVERS ...Bathymetry, Caribbean Sea, Receivers, Sonar, Technique Development, ...**7.0302**

Marinas

CRITERIA FOR THE DESIGN OF SMALL CRAFT HARBORS ...Breakwaters, Coastal Engineering-other, Harbors, Seiches, Waves, ...**8.0036**

CRITERIA FOR EVALUATING THE QUALITY OF WATER BASED RECREATION FACILITIES ...Boating, Fishing, Standards, Swimming, User Characteristics, Water Quality-general, ...**9.0015**

BACTERIOLOGICAL AND ESTHETIC OF PLEASURE BOAT WASTE DISCHARGE ON SMALL HARBORS ...Bacterial Pollutant Sources, Beautification, Harbors, Ship Wastes, Water Analysis, ...**6.0191**

Marine Biology

SEAWATER/SEDIMENT/B OLOGY MONITORING PROGRAM ...Data Acquisition, Sediments-other, Water Analysis-general, ...**1.0144**

ATLANTIC OCEANIC BIOLOGY ...Atlantic Ocean-general, Ships and Cruises, ...**4.0126**

CONFERENCE REPORTS ...Geophysics-general, Meetings, Tables, Compilations, Catalogs, ...**11.0034**

BIOLOGY CONFERENCE SERIES ...Ecology (animal), Meetings, Plant Ecology (non-specific), ...**11.0035**

ARCTIC FIELD RESEARCH ...Arctic, Geology-general, Glaciology-general, Micrometeorology, ...**11.0010**

MARINE BIOLOGY RESEARCH AT THE BERMUDA BIOLOGICAL STATION ...Bermuda, Ecology (animal), Marine Biology (non-specific), Plant Ecology (non-specific), ...**12.0006**

COOPERATIVE RESEARCH AND RESEARCH TRAINING PROGRAM IN BIOLOGICAL OCEANOGRAPHY ...Ships and Cruises, Teaching and Research, ...**12.0040**

SUPPORT OF TRAINING PROGRAMS IN INVERTEBRATE ZOOLOGY AND MARINE BOTANY ...Invertebrates -non-specific, Marine Environments-general, Marine Plants, Meetings, Training Grants, Fellowships, ...**11.0028**

A TRAINING PROGRAM FOR GRADUATE STUDENTS IN MARINE SCIENCES AT THE FRIDAY HARBOR LABORATORIES ...Marine Biology (non-specific), Training Grants, Fellowships, Washington, ...**11.0042**

LOGISTIC SUPPORT, MAINTENANCE AND RENOVATION OF FACILITIES ...Facilities, Maine, Marine Plants, ...**12.0029**

INVESTIGATIONS IN MARINE BIOLOGY ...Massachusetts, Teaching and Research, ...**11.0027**

SUPPORT OF RESEARCH VESSEL VELERO 4 ...California, Equipment Purchase Operation, Facilities, Geology-general, Instrumentation-general, Training Grants, Fellowships, ...**4.0115**

SUPPORT OF UNIVERSITY OF GEORGIA MARINE INSTITUTE RESEARCH VESSEL OPERATION ...Continental Shelf, Continental Slope, Distribution, Environmental Ecology, Estuaries, Geomorphology-topography, Pollution Sources-general, Ships and Cruises, Textures-structures, ...**12.0026**

STANFORD BIOLOGICAL OCEANOGRAPHY ...Phytoplankton, Primary Productivity, Productivity - Food Chain, Ships and Cruises, Training Grants, Fellowships, Zooplankton, ...**11.0005**

SUPPORT OF THE RESEARCH VESSEL AHOYOHA III ...California, Diving and Scuba, Equipment Purchase Operation, Geology-general, Ships and Cruises, ...**12.0008**

RESEARCH TRAINING LABORATORY ...Facilities, Massachusetts, ...**12.0032**

LOGISTIC SUPPORT AND MAINTENANCE OF FACILITIES ...Atlantic Ocean-north, Facilities, Lakes, Maine, ...**12.0030**

APPLIED MARINE ENGINEERING PROGRAM AT SCRIPPS INSTITUTION OF OCEANOGRAPHY ...California, Engineering Studies-general, Harbors, Marine Biology (non-specific), Other-design-and-construction, Scientific-service-support, Teaching and Research, Training Grants, Fellowships, ...**11.0006**

THE POSTPLEISTOCENE OCEANOGRAPHY AND BIOLOGY OF THE EASTERN NORTH PACIFIC ...Climatography, Ocean History, Pacific Ocean-east, Pacific Ocean-north, ...**7.0158**

SUPPORT FOR THE OPERATION OF OCEANOGRAPHIC RESEARCH VESSELS ...Black Sea, Mediterranean Sea-general, Sedimentation, Ships and Cruises, Water Analysis-general, ...**11.0030**

SUPPORT OF RESEARCH VESSEL AT LAMONT GEOLOGICAL OBSERVATORY ...Distribution, Patterns, Ridges, Seismic Studies, Ships and Cruises, ...**12.0037**

SUPPORT OF TWO RESEARCH VESSELS ...Air-sea Boundary-general, General Sea Water Chemistry, Great Lakes-general, Ships and Cruises, Water Properties-general, ...**12.0034**

PARTICIPATION IN USARP EXPEDITIONS ...Antarctica, Data Acquisition, Data Analysis - General, Ships and Cruises, Teaching and Research, ...**12.0012**

FACTORS INFLUENCING THE INTENSITY OF BIOLUMINESCENCE ...Bioluminescence, Cell. env.(non-specific & Ot.), Kinetics, Optical, Trace Elements, ...**1.0169**

THE OCCURRENCE AND EFFECTS OF PLANKTON IN THE SEA ...Air-sea Boundary-general, Plankton (non-specific), ...**5.0781**

ACOUSTIC-VIDEO SYSTEM FOR AQUATIC BIOACOUSTICAL AND ETHOLOGICAL RESEARCH ...Acoustical, Behavioral Ecology, British West Indies, Marine Environments-general, ...**1.0049**

BIOMETRY ...Navigation, Population Dynamics, Statistics-general, Temporal Distribution, ...**4.0019**

CHEMICAL STUDIES OF THE OCEANIC ENVIRONMENT ...Chemical Reactions, Mixing, Oceanic Fronts, Pacific Ocean-east, Trace Elements, Water Analysis-general, ...**1.0136**

ARCTIC SUB-ICE STUDY ...Acoustical, Arctic Ocean, Sea Ice, Submersibles, ...**3.0074**

RESEARCH IN OCEAN PROPERTIES ...Acoustical, Geomorphology-topography, Geophysical Equipment, Model Studies, Seismic Studies, Subbottom, ...**7.0132**

BIOTELEMETRY ...Instrumental Services, Marine Biology (non-specific), Telemetry, ...**8.0070**

FOULING OF SENSORS ...Fouling, Inhibitors, Instrumentation-general, Organometallics, ...**8.0239**

HANDBOOK OF MARINE TECHNOLOGY ...Engineering Studies-general, General Sea Water Chemistry, Geology-general, Handbooks, Meteorological Studies, Submersibles, ...**11.0014**

DEEP OCEAN RESEARCH AND DEEP OCEAN ENGINEERING ...Abyssal, Engineering Studies-general, Geophysics-general, Structural Studies, Submersibles, Textures-structures, ...**4.0131**

MARINE BIOLOGY STUDIES ON FAIRFAX ISLAND ...Australia, Collections, Data Acquisition, Islands, Reefs, ...**5.0874**

SUPPORT OF THE MARINE BIOLOGY PROGRAM AT THE LAMONT GEOLOGICAL OBSERVATORY ...Equipment Purchase Operation, New York, ...**11.0033**

A PROGRAM FOR THE TRAINING OF STAFF MEMBERS FROM THE SCHOOL OF FISHERIES OF THE CATHOLIC UNIVERSITY OF VALPARAISO CHILE ...Chile, Fish -non-specific, Food Processing Industry, Teaching and Research, ...**5.0181**

THE ECOLOGICAL ARCHITECTURES OF THE MARINE BIOSPHERE ...Marine Biology (non-specific), ...**5.0859**

OCEANOGRAPHIC SURVEY OF CONTINENTAL SHELF WATERS OFF CHESAPEAKE BAY ...Chesapeake Bay, Continental Shelf, Salinity, Temperature, ...**4.0135**

SEA USE ...General Synoptic Observations, Oceanography-general, Pacific Ocean-east, Platforms, Seamounts-guyots, ...**7.0303**

OCEANOGRAPHIC RESEARCH ...Acoustical, Density, Gases, Thermal, Water Motion, ...**1.0142**

MARINE POLYCHAETE WORMS OFF THE COLUMBIA RIVER, OREGON ...Animal Taxonomy, Collections, Lugworms, Marine Segmentedworm, ...**5.0575**

BIOLOGICAL OCEANOGRAPHY ...Acoustical, Atlantic Ocean-north, Sound Production, Submersibles, ...**1.0022**

BIOLOGICAL OCEANOGRAPHY AND DETERIORATION, POLYMER STUDIES ...Corrosion General, Lubricants and Fluids, Marine Biology (non-specific), Plankton (non-specific), Wear, Friction, ...**8.0235**

TISSUE CULTURE - VIROLOGY ...Animal Viruses (non-specific), Bacteria (non-specific), Cell Injury and Autolysis, Monolayer Culture, Oysters, Tissues, ...**5.0978**

COASTAL AND INSHORE OCEANOGRAPHY ...Alaska, Estuaries, Shoreline - Coastline, Water Analysis-general, Water Properties-general, ...**5.0851**

POPULATION DYANMICS (BIOMETRICS) OF EXPLOITED FISH GROUPS OF THE NORTH PACIFIC OCEAN AND PACIFIC COAST ...Meteorological Studies, Model Studies, Number Or Density, Pacific Ocean-north, Population Dynamics, ...**5.0167**

146 D EASTROPAC ...Meteorological Studies, Pacific Ocean-east, Tropic, Tuna, Mackerel, Albacore... , Vertical Distribution, ...**4.0113**

SURVEY, EVALUATION & SUMMARIZATION OF LITERATURE ON ENVIRONMENTAL REQUIREMENTS OF MARINE ORGANISMS LEVELS OF POTENTIAL TOXICANTS (ABBREV ...Biology, Chemical, Environmental Effects-geologic, Geosciences, Library, Marine Environments-general, Survey Studies, ...**4.0037**

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT MARINE PHYTOPLANKTON SPECIES ...Axenic Culture, Growth and Differentiation, Marine Plants, Phytoplankton, Responses to Growth, ...**5.0833**

ARCTIC EAST OCEANOGRAPHIC PROJECT (OCEANOGRAPHY OF THE BAFFIN BAY REGION) ...Baffin Bay, Circulation-general, Polar, Sea Water Chemistry-other, Water Properties-general, ...**4.0125**

STANDING STOCK AND GROWTH OF BACTERIA IN THE SEA ...Atp X Adenosine Triphosphate, Carbohydrates, Growth (non-specific & Ot.), Phytoplankton, Standing Crops, ...**5.0749**

UPTAKE OF ORGANIC COMPOUNDS BY MARINE INVERTEBRATES ...Amino Acids, Amino Acids -non-specific, Chemoreceptors, Invertebrate Nutrition, Invertebrates -non-specific, Metabolism, Pulse-labelling, ...**5.0938**

PROVIDE RESEARCH FACILITIES AND SERVICES ...Facilities, ...**12.0033**

RADIOBIOLOGICAL RESEARCH ON MARINE ORGANISMS ...Facilities, Marine Biology (non-specific), ...**11.0029**

Marine Animals

POPULATION STUDIES OF HAUSTORIIDAE AND GAMMARIDAE FROM NEW ENGLAND AND ON INFAUNAL AND EPIFAUNAL MARINE AMPHIPODS AT ENIWETOK ...Atolls , Habitat Studies, Micronesia, Population Dynamics, Shrimp - Amphipods, ...**5.0466**

CELL DIVISION, BIOENERGETICS, CHEMISTRY OF MUSCLE ...Bioenergetics, Cell Cycle, Configuration, Glyoxal, Organic, ...**5.0987**

FILAMENTS, MORPHOGENESIS AND CONTRACTION OF MUSCLE ...Contraction and Relaxation, Fibrils and Filaments, Subunits, ...**5.0986**

FISHERIES OCEANOGRAPHY AND ENVIRONMENTAL ASSESSMENT AND PREDICTION ...Commercial Fishing, Convection, Oceanography-general, Spacecraft Sensory Devices, Thermal, ...**4.0150**

SPECTRAL SIGNATURES OF FISH SCHOOL IDENTIFICATION ...Atomic Absorption, Fish -non-specific, Oil, Oils -fats, Spectral Reflectance, ...**4.0151**

DETECTION AND CLASSIFICATION OF FISH AND MINERAL OIL SLICKS BY REMOTE SENSING FROM ORBITAL ALTITUDE ...Fish -non-specific, Oil, Oils -fats, Spectral Reflectance, Ultra - Violet Radiation, ...**4.0140**

NEUROPHYSIOLOGICAL INVESTIGATIONS OF LIMULUS CENTRAL NERVOUS SYSTEM ...Brain, Cardiovascular, Horseshoe Or King Crabs, Nervous System, ...**5.0469**

THE ACCUMULATION OF FISSION PRODUCTS BY MARINE FISH AND SHELLFISH ...Chlorideae (non-specific & Ot), Contamination - Water, Estuaries, Food Chains, Radioactivity-general, Radioecology, ...**6.0167**

STUDIES ON THE PHYSIOLOGY OF MARINE ORGANISMS USING RADIOISOTOPES ...Equipment Purchase Operation, Facilities, Marine Plants, Radioisotopes -non-specific, ...**12.0031**

A NEW APPROACH TO NUTRITION, PHYSIOLOGY, AND MINERAL CYCLING OF FORAMINIFERA ...Axenic Culture, Foraminifera, Invertebrate Nutrition, Metabolism, Productivity - Food Chain, ...**5.0809**

A STUDY OF THE DEEP CIRCULATION AND DEEP FISH POPULATIONS IN THE PACIFIC OCEAN ...Currents-ocean, Fish -non-specific, Pacific Ocean-general, Tides, Vertical Distribution, ...**2.0005**

BIOLOGICAL PRODUCTIVITY IN THE SARGASSO SEA, THE GULF STREAM AND IN THE ATLANTIC COASTAL WATERS OFF CAPE HATTERAS ...Continental Shelf, Phytoplankton, Primary Productivity, Productivity - Food Chain, Proteins, ...**5.1005**

INOCULATED PACK STUDIES ON LOW-DOSE IRRADIATED MARINE PRODUCTS - SHRIMP ...Clostridium Botulinum, Microbiological, Oysters, Radiation, Shrimp, ...**6.0017**

RADIOELEMENT STUDIES IN THE OCEANS- PLANKTON DISTRIBUTION STUDIES ...Chemical Reactions, Foraminifera, Number Or Density, Protozoa -other, Vertical Distribution, ...**5.0795**

SEASONAL DISTRIBUTION AND ABUNDANCE OF DEMERSAL FISH AND INVERTEBRATES IN THE MARINE WATERS ADJACENT TO THE MOUTH OF THE COLUMBIA RIVER ...Benthic Fauna, Number Or Density, Productivity - Food Chain, Radioactivity-general, Temporal Distribution, Vertical Distribution, ...**5.0930**

MECHANISM STUDIES ON BIOLUMENESCENT REACTIONS WITH EMPHASIS ON ENERGY TRANSFER PROBLEMS ...Bioluminescence, Energy Conversion, Luciferase, Luciferin, ...**1.0164**

COMMUNICATIONS STUDIES ON TURSIOPS TRUNCATUS AND OTHER DELPHINIDS ...Central Nervous System, Linguistics, Mammals, Neuristors Neurol Nets, Sound Production, ...**5.0587**

FACTORS AFFECTING THE BEHAVIOR OF SHARKS ...Behavior, Sensory Organs, Sharks, ...**5.0262**

SHARK ATTACKS ...Behavioral Ecology, Diving and Scuba, Sharks, Water Environment -other, ...**6.0090**

BIOLOGICAL INSTRUMENTATION ...Behavioral Ecology, Biological Sciences, Instrumental Services, Instrumentation-general, Navigation Systems-other, ...**8.0064**

MARINE BIOLOGY IN ALASKA ...Alaska, Amino Acids -non-specific, Polar, Porifera, Trenches, ...**5.0854**

ATLANTIC OCEANIC BIOLOGY ...Atlantic Ocean-general, Marine Biology, Ships and Cruises, ...**4.0126**

INFECTIONS IN MARINE MAMMALS USED AS LABORATORY ANIMALS ...Detection, Infectious Conditions and Dis, Mammals, Vertebrate Pathology, ...**5.0549**

MID-DEPTH BIOLUMINESCENCE ...Bioluminescence, Crustacea -non-specific, Vertical Distribution, ...**1.0162**

AGING IN HYDROIDS ...Aging, Cell Injury and Autolysis, Developmental Physiology, Environmental Physiology, Hydra, Portuguese Man-of-war, Senescence, ...**5.0597**

SHARK RESEARCH ...Control of Nuisance Species, Fish Repellents, Sharks, Tags, Temporal Distribution, ...**5.0047**

UPTAKE AND ASSIMILATION OF ORGANIC COMPOUNDS IN MARINE ORGANISMS ...Active Transport, Invertebrates -non-specific, Metabolism, Nutrition, Organics, Productivity - Food Chain, ...**5.0937**

MARINE COMMUNITIES ...Benthic Organisms (non-specif), Environmental Ecology, Life History Studies, Model Studies, Plankton (non-specific), ...**5.0861**

CONTROLLED ENVIRONMENTAL FACTORS ON THE DEVELOPMENT OF ESTUARINE AND OCEANIC CRUSTACEA ...Aquatic Ecology, Crabs, Developmental Physiology, Estuaries, Salinity, Temperature, ...**5.0476**

PHYSIOLOGICAL MECHANISMS UNDERLYING THE BEHAVIOR OF MARINE CRUSTACEA ...Behavior, Behavioral Ecology, Crabs, Shrimps - Common, ...**5.0428**

EVOLUTION OF ALL-FEMALE FISHES ...Female, Gambusia, Molly, Other, Reproduction Studies (general), ...**5.0247**

PARASITIC COPEPODA %CRUSTACEA*ROM INVERTEBRATES AND FISHES ...Animal Taxonomy, Copepods, Ectoparasites, Indian Ocean-general, Invertebrate Anatomy, ...**5.0451***

CAROTENOIDS, CAROTENOID CHROMOPROTEINS, AND ASSOCIATED LIPIDS IN ANIMALS ...Carotenoid Pigments, Catabolism and Degradation, Metabolism, Pigments - Animal-non-specific, ...**5.0944**

RESEARCH ON INDO-WEST PACIFIC MARINE MOLLUSKS OF THE FAMILY CONIDAE ...Animal Taxonomy, Gastropods -slugs,conch,snails, Indian Ocean-general, Invertebrate Anatomy, Number Or Density, ...**5.0517**

THE PORIFERA OF FANNING ISLAND, CENTRAL PACIFIC ...Animal Taxonomy, Dispersion -other, Environmental Effects-geologic, Line Islands, Porifera, ...**5.0539**

PORCELLANID CRABS OF AUSTRALIA ...Australia, Collections, Crabs, Museum, Nomenclature, Classification, ...**5.0354**

SUPPORT OF TRAINING PROGRAMS IN INVERTEBRATE ZOOLOGY AND MARINE BOTANY ...Invertebrates -non-specific, Marine Biology, Marine Environments-general, Marine Plants, Meetings, Training Grants, Fellowships, ...**11.0028**

DYNAMICS OF OCEANIC PLANKTON ...Growth Rate, Number Or Density, Productivity (agricultural), RNA , Zooplankton, ...**5.0825**

THE ALPHEID SHRIMP OF AUSTRALIA ...Animal Taxonomy, Australia, Collections, Pubilications -other, Shrimps - Common, ...**5.0425**

THE ECOLOGY, MIGRATIONS AND BEHAVIOR OF MARINE TURTLES ...Behavioral Ecology, Migration, Reptile Studies -other, Spawning & Nesting Sites, Turtles, Terrapins, Tortoises, ...**5.0586**

STRUCTURE OF THE FISH FAUNA OF A FLORIDA CORAL REEF ...Ecological, Fish -non-specific, Reefs, Vertical Distribution, ...**5.0205**

STUDIES IN THE PHYSIOLOGY AND BIOCHEMISTRY OF DEEP-SEA FISHES ...Environmental Physiology, Fish -non-specific, Metabolism, Vertical Distribution, Water Pressure, ...**5.0237**

ECOLOGY OF THE PORITES FURCATA REEF-FLAT COMMUNITY ...Anthozoa, Panama, Productivity - Food Chain, Puerto Rico, Reefs, ...**5.0867**

VISUAL AND ACOUSTICAL COMMUNICATION IN CERTAIN MARINE CRUSTACEANS ...Atlantic Ocean-north, Auditory, Behavior, Crabs, Visual Organs, ...**5.0430**

TREMATODES OF FISHES OCCURRING ON THE WEST COAST OF NORTH AMERICA. ...Collections, Comparative Physiology, Nearctic, Pacific Ocean-general, Trematoda -other, ...**5.0636**

MONOGRAPH OF THE CEPHALOPODS OF THE NORTH ATLANTIC ...Animal Taxonomy, Atlantic Ocean-north, Depth, Nomenclature, Classification, Optical, Pubilications -other, Salinity, Temperature, ...**5.0411**

ECOLOGY AND SEDIMENTARY PATTERNS OF FORAMINIFERA ...Chemistry, Environmental Ecology, Environmental Effects-geologic, Foraminifera, Vertical Distribution, ...**5.0746**

DEVELOPMENT IN ILYANASSA ...Basic Embryology, Gastropods -slugs,conch,snails, Metabolic Inhibitors, Other, ...**5.0594**

CYTOLOGICAL CHARACTERISTIC ...Animal Taxonomy, Basic Embryology, Porifera, Speciation, Structural Functions, ...**5.0557**

TAXONOMY AND ECOLOGY OF NEARSHORE MARINE OSTRACODA ...Animal Taxonomy, Biofacies, Class Ostracoda, Ecological, Environmental Ecology, Paleoenvironments, Shrimps - Seed Or Mussel, ...**5.0707**

IONIC REGULATION IN THE QUEEN CONCH, STROMBUS GIGAS LINNAEUS ...Blood Plasma and Serum, Digestive System, Gastropods -slugs,conch,snails, Osmoregulation, ...**5.0407**

SYSTEMATIC STUDIES ON HERMIT CRABS AND OTHER DECAPOD CRUSTACEANS ...Animal Taxonomy, Atlantic Ocean-south, Crabs, Developmental Physiology, Life History Studies, ...**5.0408**

A COMPARATIVE SYSTEMATIC INVESTIGATION OF MARINE CILIATES IN THE HOLOTRICHOUS PROTOZOAN ORDER HYMENOSTOMATIDA ...Animal Taxonomy, Cilia and Flagellae, Ciliates, Comparative Physiology, Invertebrate Anatomy, ...**5.0840**

PERCEPTUAL, VOCAL, AND ECHO-RANGING BEHAVIOR OF SEALS AND SEA LIONS ...Auditory, Echolocation, Seals, Sound Production, Visual Organs, ...**5.0547**

WATER AND SALT REGULATION IN NEREID POLYCHAETES ...Active Transport, Comparative Physiology, Lugworms, Marine Segmentedworm, Osmoregulation, Salt, ...**5.0648**

CYTOTAXONOMIC STUDIES OF TELEOST FISHES ...Abyssal, Animal Taxonomy, Blood Cells, Minnows, Sets of Chromosomes, ...**5.0242**

MARINE ZOOGEOGRAPHY ...Fish -non-specific, Tables, Compilations, Catalogs, ...**5.0593**

ICHTHYOFAUNA OF THE FLORIDA CURRENT ...Fish -non-specific, Florida, Number Or Density, Temporal Distribution, Vertical Distribution, ...**5.0066**

ECOLOGY OF SKELETAL PLANKTON ...Animal Taxonomy, Collections, Flagellates, Gastropods -slugs,conch,snails, Paleoenvironments, Temporal Distribution, Vertical Distribution, ...**5.0997**

RESEARCH IN MARINE BENTHIC ECOLOGY OFF OREGON ...Benthic Fauna, Environmental Ecology, Number Or Density, Oregon, Vertical Distribution, ...**5.0916**

MARINE VERTEBRATES OF THE CALIFORNIA PENINSULA ...Animal Taxonomy, California, Environmental Ecology, Range Or Territorial Distr. , Temperature, ...**5.0554**

RELATIONSHIPS AMONG POPULATIONS OF LIMNORIA TRIPUNCTATA ...Animal Taxonomy, Isopods, Population Dynamics, Reproductive System, ...**5.0477**

ENERGY REQUIREMENTS OF MARINE ORGANISMS ...Energy, Sharks, Thermoregulation, Tuna, Mackerel, Albacore... , Water Pressure, ...**5.0273**

MICROSTRATIFICATION OF MARINE ZOOPLANKTON ...Environmental Physiology, Growth Rate, Thermal, Vertical Distribution, Zooplankton, ...**5.0753**

CHARACTERIZATION AND MODE OF ACTION OF PROTEIN VENOMS OF MARINE ANIMALS ...Lecithin, Mechanism of Action, Sea Urchins & Other Echinoderm, Toxicology, Toxins, Venom, ...**6.0102**

RESEARCH TRAINING IN MARINE BIOLOGY, PALEONTOLOGY AND SYSTEMATIC ZOOLOGY ...Animal Taxonomy, Invertebrates -non-specific, Oceanography-general, Paleontology, Training Grants, Fellowships, ...**11.0003**

LOGISTIC SUPPORT, MAINTENANCE AND RENOVATION OF FACILITIES ...Facilities, Maine, Marine Biology, Marine Plants, ...**12.0029**

SYSTEMATICS OF DEEP SEA TREMATODES ...Animal Taxonomy, Helminths, Organic Evolution, Trematoda -other, Vertical Distribution, ...**5.0646**

PREDATOR PREY RELATIONSHIPS BETWEEN ECHINODERMS AND MOLLUSCE ...Behavior, Behavioral Ecology, Gastropods -slugs,conch,snails, Predation, Starfishes, ...**5.0351**

NUTRITIONAL STUDIES ON MARINE ORGANISMS ...Crustacea -non-specific, Invertebrate Nutrition, Nutrition Studies, Organics, Phytoplankton, ...**5.1001**

RESEARCH ON THE BIO-SYSTEMATICS OF THE CIRRIPEDIA ...Barnacles, Biological Rhythms, Developmental Physiology, Visual Organs, ...**5.0364**

PRODUCTIVITY OF OCEANIC POPULATIONS OF VERTICALLY MIGRATING ANIMALS ...Migration, Plankton (non-specific), Population Dynamics, Productivity (agricultural), Vertical Distribution, ...**5.1019**

ECOLOGICAL, EXPERIMENTAL AND COMPUTER STUDIES OF ENDOGENOUS RHYTHMICITY ...Biological Rhythms, Brain, Computer Methods -general, Crustacea -non-specific, Locomotion, ...**5.0361**

PHYSIOLOGY OF MARINE MAMMAALS ...Environmental Physiology, Mammals, Seals, ...**5.0624**

EVOLUTIONARY DIVERGENCE OF DEEP WATER MARINE ANNELIDS ...Comparative Physiology, Digestive System, Environmental Physiology, Lugworms, Marine Segmentedworm, Vertical Distribution, ...5.0662

SHORE FISHES OF ANNOBON AND FERNANDO POO ...Art Work-illustrations-etc, Atlantic Ocean-general, Collections, Fish -non-specific, Museum, ...5.0067

GAMETOGENESIS AND FERTILIZATION IN THE BLUE CRAB, CALLINECTES SAPIDUS RATHBUN, AND OTHER CRABS ...Crabs, Electron Microscopy, Histochemistry - Cytochem, Reproductive System, Structural Functions, ...5.0478

ENVIRONMENTAL SIGNIFICANCE OF SABELLARIID REEFS ...Biology, Habitat Studies, Lugworms, Marine Segmentedworm, Reefs, ...5.0592

DEVELOPMENT AND EVALUATION OF A NEW TECHNIQUE FOR SAMPLING ZOOPLANKTON ...Organism Sampling Devices, Population Dynamics, Productivity - Food Chain, Technique Development, Vertical Distribution, Zooplankton, ...5.0786

SENSORY PROCESSES, MARINE AND HUMAN ...Bioelectric Phenomena, Nervous System, Pathways, Sensory Organs, Visual, ...5.0969

SUPPORT OF RESEARCH VESSELS JOHN ELLIOTT PILLSBURY, GERDA, TURSIOPS ...Microfossils, Mineralogy, Paleotemperature, Petrology, Seismic Studies, Ships and Cruises, ...12.0024

SIMULATION STUDIES OF ECOLOGICAL COMMUNITIES ...Mortality Rates, Number Or Density, Population Dynamics, Predation, Productivity - Food Chain, ...5.0862

BIOLOGY OF THE DEEP-SEA BENTHOS ...Atlantic Ocean-general, Benthic Fauna, Number Or Density, Tropic, Vertical Distribution, ...5.0902

FERTILIZATION MECHANISMS AND GAMETE PHYSIOLOGY IN MARINE INVERTEBRATES ...Basic Embryology, Male Gametes, Metabolism, Reproductive System, Sea Urchins & Other Echinoderm, ...5.0590

NUTRITION AND PHYSIOLOGY OF MARINE FISH IN CONTROLLED GNOTOBIOTIC ENVIRONMENTS ...Aquaria, Environmental Physiology, Fish -non-specific, Germ Free Animal, Nutrition -other, ...5.0317

STRUCTURE AND FUNCTION OF CELL ORGANELLES DURING GROWTH AND DEVELOPMENT ...Acrosomes, Basic Embryology, Differentiation Mechanism, Nucleolus, Ribosomes, ...5.0935

EVOLUTIONARY DIVERGENCE OF ONUPHID POLYCHAETES ...Comparative Physiology, Environment Resistance, Environmental Physiology, Invertebrate Nutrition, Lugworms, Marine Segmentedworm, Water Temperature-non-specific, ...5.0663

RENAL SALT EXCRETION IN MARINE BIRDS ...Kidney and Urinary System, Osmoregulation, Shorebirds-gulls,terns,skimmer, Urine, ...5.0562

REPRODUCTIVE RELATIONSHIPS AMONG POPULATIONS OF A MARINE WOOD-BORING ISOPOD ...Animal Taxonomy, Invertebrate Anatomy, Isopods, Population Dynamics, Reproductive System, ...5.0414

OCEANIC FISHES OF THE TROPICAL ATLANTIC ...Atlantic Ocean-south, Fish -non-specific, Survey Studies, Tropic, Vertical Distribution, ...5.0068

STUDIES ON EMBRYONIC CELLS ...Basic Embryology, Chickens, Reproductive System, Sea Squirts - Tunicates, Suspension Culture, ...5.0945

DEEP-WATER ZOOPLANKTON OF THE SARGASSO SEA ...Abyssal, Bermuda, Sargasso Sea, Vertical Distribution, Zooplankton, ...5.0738

ECOLOGICAL STUDY OF CHARLOTTE HARBOR ESTUARY AND SHARK PROGRAM OF MOTE MARINE LAB ...Estuaries, Florida, Mans Activities, Sharks, ...5.0884

ASCIDIAN SPECIES ON THE ATLANTIC CONTINENTAL SHELF ...Animal Taxonomy, Atlantic Ocean-north, Continental Shelf, Range Or Territorial Distr. , Sea Squirts - Tunicates, Vertical Distribution, ...5.0609

BARNACLES OF THE EASTERN PACIFIC ...Barnacles, Life History Studies, Pacific Ocean-east, ...5.0515

FACTORS AFFECTING HORIZONTAL DISTRIBUTION OF MESOPELAGIC FISHES ...Aquatic Ecology, Atlantic Ocean-north, Behavioral Ecology, Fish -non-specific, Range Or Territorial Distr. , Vertical Distribution, ...5.0105

DIVERSITY, COMMUNITY STRUCTURE AND TROPHIC RELATIONS OF TROPICAL ZOOPLANKTON ...Bays, Interbiotic Relat.(non-specif), Productivity - Food Chain, Tropic, Zooplankton, ...5.0785

THE INFLUENCE OF DEPOSIT FEEDING BENTHOS ON THE STABILITY OF BOTTOM SEDIMENTS AND COMMUNITY TROPHIC STRUCTURE ...Benthic Fauna, Benthonic-bottom, Massachusetts, Productivity - Food Chain, Suspension, ...5.0559

BIOCHEMICAL BASIS OF SPECIFIC CELL ASSOCIATION ...Adhesion, Basic Embryology, Chickens, Pacific Ocean-general, Porifera, ...5.0946

METABOLISM OF MARINE ECOSYSTEMS ...Energy Budgets, Food Webs, Metabolism, Other, Plankton (non-specific), Productivity - Food Chain, ...5.0966

CORRELATION BETWEEN ELECTRICAL PATTERNS AND MORPHOGENETIC PATTERNS DURING REGENERATION ...Developmental Physiology, Electrical Fields, Hydra, Portuguese Man-of-war, Regeneration and Wound, ...5.0602

ZOOPHYSIOLOGY OF OCEANIC BENTHIC ANIMALS OFF THE NORTH CAROLINA COAST ...Adaptation, Atlantic Ocean-north, Benthic Fauna, Benthonic-bottom, Environmental Physiology, Water Temperature-non-specific, ...5.1009

SYSTEMATIC AND DISTRIBUTIONAL STUDY OF DEEP-SEA ECTOPROCTA (BRYOZOA) ...Adaptation, Animal Taxonomy, Bryozoa, Ecological, Vertical Distribution, ...5.0650

SYSTEMATIC STUDIES OF SPONGES OF THE JAMAICAN FORE-REEF SLOPE ...Animal Taxonomy, Habitat Studies, Invertebrate Anatomy, Jamaica, Porifera, Reefs, ...5.0558

THE ROLE OF COPROPHAGY IN MARINE FOOD CHAINS ...Feces, Invertebrate Nutrition, Nutrition -other, Productivity - Food Chain, ...5.0963

MORPHOLOGY AND PHYSIOLOGY OF THE HEART OF ECTEINASCIDIA TURBINATA ...Bermuda, Cardiovascular, Invertebrate Anatomy, Sea Squirts - Tunicates, ...5.0530

DEEP WATER BENTHIC POLYCHAETES ...Benthic Fauna, Biology, Lugworms, Marine Segmentedworm, Photography, Vertical Distribution, ...5.0540

SYSTEMATICS OF MARINE SYMBIOTIC CRUSTACEA FROM INVERTEBRATES ...Animal Taxonomy, Barnacles, Copepods, Life History Studies, Symbiosis, ...5.0516

MICROZOOPLANKTERS IN THE MARINE FOOD CHAIN ...Organism Sampling Devices, Population Dynamics, Productivity - Food Chain, Vertical Distribution, Zooplankton, ...5.0748

POPULATION GENETICS AND LARVAL ECOLOGY OF HAWAIIAN LITTORINA ...Derivatives, Gastropods - slugs,conch,snails, Hawaii, Maturity & Growth Stages, Polymorphism, ...5.0429

STUDENT RESEARCH AT THE MARINE SCIENCE CENTER ...Facilities, Intertidal Areas, Invertebrate Physiology, Invertebrates -non-specific, Oregon, Training Grants, Fellowships, ...11.0039

RECENT AND ANCIENT FAUNAS OF A DROWNED ISLAND CHAIN (MID-PACIFIC MOUNTAINS) ...Benthic Fauna, Biofacies, Coring and Dredging, Hawaii, Seamounts-guyots, ...5.0863

PHYSIOLOGICAL STUDIES IN THE BOTTLENOSE DOLPHIN TURSIOPS TRUNCATUS ...Adaptation, Cardiovascular System, Central Nervous System, Mammals, ...5.0588

GENERAL SYSTEMATIC STUDIES OF THE OCTOCORALLIA OF THE TROPICAL ATLANTIC ...Animal Taxonomy, Anthozoa, Tropic, ...5.0589

BIOSYNTHESIS OF BROMOPHENOLS IN MARINE INVERTEBRATES ...Acorn Worms, Bioluminescence, Metabolism, Phenols, ...5.0961

HOLOGRAPHIC INSTRUMENTATION FOR MARINE PLANKTON STUDIES ...Lasers and Masers, Photography, Zooplankton, ...8.0066

SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES ...Behavior, Migration, Olfactory, Salmon & Trout - Non-specific, Visual Organs, ...5.0339

GROWTH, DIFFERENTIATION AND NERVE TRANSMISSION IN THE HYDROID, CAMPANULARIA ...Basic Embryology, Developmental Physiology, Growth Rate, Hydra, Portuguese Man-of-war, Nervous System, ...5.0601

PARASITISM IN DEEPSEA FISHES ...Fish -non-specific, Helminths, Host Specificity, Protozoa, Vertical Distribution, ...5.0243

ECOLOGICAL INVESTIGATIONS OF MCMURDO SOUND ZOOPLANKTON ...Animal Taxonomy, Antarctica, Migration, Vertical Distribution, Zooplankton, ...5.0756

SYMBIOSIS BETWEEN MARINE ALGAE AND INVERTEBRATES ...Gastropods -slugs,conch,snails, Photosynthetically Active, Symbiosis, Zooxanthella, ...**5.0730**

DISTRIBUTION OF THE MID-WATER FISHES OF THE GULF OF CALIFORNIA ...Environmental Ecology, Fish -non-specific, Gulf of California, Nets, Organism Sampling Devices, Vertical Distribution, ...**5.0043**

USEFUL BIOMEDICAL MATERIALS DERIVED FROM THE SEA - AN INTERDISCIPLINARY APPROACH ...Antibody Formation, Bioluminescence, Immunology, Molec. struct. (gen. & Other), ...**6.0106**

STUDY OF RADIOLARIA IN SURFACE SEDIMENTS OF THE NORTHEAST PACIFIC OCEAN ...Animal Taxonomy, Biogenous, Pacific Ocean-north, Protozoa -other, Vertical Distribution, ...**7.0187**

MODERN FORAMINIFERA OFF OREGON ...Continental Shelf, Foraminifera, Oregon, Pacific Ocean-general, Vertical Distribution, ...**5.0820**

ANATOMICAL INVESTIGATIONS OF THE LOBODONTINAE ...Collections, Ross Sea, Seals, Vertebrate Anatomy, ...**5.0614**

OPERATIONAL SUPPORT OF OCEANOGRAPHIC RESEARCH VESSELS ...Facilities, Geophysics-general, Hawaii, Sediments-general, Structural Studies, ...**12.0027**

PYCNOGONIDA OF THE ANTARCTIC REGIONS ...Animal Taxonomy, Antarctica, Benthic Fauna, Collections, Sea Spiders, ...**5.0647**

POPULATION DYNAMICS OF ANTARCTIC SEALS ...Aerial Photography, Antarctica, Migration, Population Dynamics, Seals, ...**5.0634**

SYSTEMATIC STUDIES OF ANTARCTIC COPEPODS ...Animal Taxonomy, Antarctic Ocean, Copepods, Mixing, ...**5.0461**

COOPERATIVE SYSTEMATICS STUDIES IN ANTARCTIC BIOLOGY ...Animal Taxonomy, Antarctica, Cooperative-studies, Equipment Purchase Operation, Invertebrates -non-specific, ...**5.0581**

CETACEA OF TIERRA DEL FUEGO ...Facilities, Mammals, Survey Studies, Tierra Del Fuego, Travel Grants, ...**5.0544**

SYSTEMATICS OF ANTARCTIC HYMENOSTOMATIDA (PROTOZOA) ...Animal Taxonomy, Antarctica, Aquatic Ecology, Ciliates, Habitat Studies, ...**5.0815**

BIOLOGY OF THE ANTARCTIC BRACHIOPOD FAUNA ...Animal Taxonomy, Museum, Range Or Territorial Distr. , ...**5.0454**

PARASITES OF ANTARCTIC VERTEBRATES AND INVERTEBRATES ...Animal Taxonomy, Antarctic Ocean, Collections, Ectoparasites, Endoparasites -other, ...**5.0658**

SYSTEMATICS AND ZOOGEOGRAPHY OF ANTARCTIC CEPHALOPODS ...Animal Taxonomy, Antarctic Ocean, Australian, Octopus, Squid, Cuttlefish... , Pubilications -other, ...**5.0412**

THE STATUS AND POTENTIAL OF AQUACULTURE ...Algal Culture, Aquaculture & Fish-farming, Fish -non-specific, Food Supply, Survey Studies, ...**8.0003**

BIO-ACOUSTIC AND BIOLOGICAL SAMPLING GEAR STUDIES ...Acoustical, Indian Ocean-general, Mapping, Organism Sampling Devices, Plankton (non-specific), ...**8.0126**

PELAGIC SHARKS OFF SOUTHERN CALIFORNIA ...Environmental Ecology, Pacific Ocean-east, Population Dynamics, Sharks, Vertical Distribution, ...**5.0196**

PHYSALIA TOXIN AND THE ACTIVITY OF BIOLOGICAL MEMBRANES ...Active Transport, Animal Toxins, Cellular Membranes (non-spec.), Jelly Fish, Toxicology, ...**6.0107**

MARINE ECOLOGICAL STUDIES ...Environmental Ecology, Habitat Studies, Intertidal Areas, Invertebrates -non-specific, Stress, ...**5.0917**

BEHAVIOR AND SPECIFICITY IN MARINE SYMBIOSIS ...Behavioral Ecology, Environmental Ecology, Fouling, Symbiosis, ...**5.0951**

ORIENTATION CUES AND PATTERNS OF LONG-DISTANCE TRAVEL OF MARINE TURTLES ...Biological Rhythms, Environmental Physiology, Migration, Orientation, Turtles, Terrapins, Tortoises, ...**4.0102**

PHARMACOLOGY AND CHEMISTRY OF TOXIC MARINE ANIMALS ...Animal Toxins, Female Gametes, Sculpins, Toxicology, ...**6.0104**

BEHAVIORAL STUDIES OF CETACEANS ...Behavioral Ecology, Locomotion -animal, Mammals, Sound Production, ...**5.0596**

ECOLOGY OF MARINE BIVALVE MOLLUSCAN LARVAE ...Behavioral Ecology, Clams, Fouling, Population Dynamics, Productivity - Food Chain, Vertical Distribution, ...**5.0370**

BEHAVIOR AND SONIC ACTIVITY OF FISHES ...Behavioral Ecology, Environmental Physiology, Fish -other, Sonar, Sound Production, ...**1.0047**

EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC ...Animal Toxins, Pacific Ocean-general, Toxicological and Allergy, Toxicology, ...**6.0110**

STUDIES ON MOLTING, GROWTH, AND DEVELOPMENT IN ACORN BARNACLES AND LARVAL DECAPODS ...Barnacles, Biological Rhythms, Developmental Physiology, Endocrine System, Fouling, ...**5.0296**

DETERMINANTS AND CONTROL OF UNDERWATER VOCALIZATIONS IN THE CALIFORNIA SEA LION ...Acoustical, Mammals, Seals, Sound Production, ...**1.0003**

ARCTIC SUB-ICE STUDY ...Acoustical, Arctic Ocean, Marine Biology, Sea Ice, Submersibles, ...**3.0074**

BLOOD CHEMISTRY OF FISHES ...Blood Plasma and Serum, Bone, Sharks, Vertebrate Anatomy, Vertical Distribution, ...**5.0239**

BIOLOGICAL OCEANOGRAPHY ...Arctic, Organics, Phytoplankton, Temporal Distribution, ...**5.1038**

PRESSURE EFFECTS ON MARINE ORGANISMS ...Abyssal, Environmental Physiology, Pressure, Vertical Distribution, Water Pressure, ...**5.0943**

DEEP SEA BENTHOS IN THE GULF OF MEXICO ...Benthic Fauna, Benthonic-bottom, Biology, Gulf of Mexico, Population Dynamics, ...**5.0655**

INTERACTIONS OF INTERTIDAL POPULATIONS ...Competition, Habitat Studies, Intertidal Areas, Population Dynamics, Predation, ...**5.0864**

PHYSIOLOGY OF LUMINESCENT SIGNAL SYSTEMS ...Bioluminescence, Photoreception, Trace Elements, Visual Organs, ...**5.0950**

WHISTLE CONTOURS IN ODONTOCETE CETACEANS ...Behavioral Ecology, Mammals, Social Behavior, Sound Production, ...**5.0538**

BIOLOGIC SOUND SCATTERING ...Acoustical, Population Dynamics, Reverberation, Scattering, Vertical Distribution, Zooplankton, ...**1.0060**

DEEP-WATER FOULING ...Biological, Fish -non-specific, Fouling, Predation, Vertical Distribution, ...**8.0233**

MARINE BIOLOGY OF RED SEA AND EASTERN MEDITERRANEAN ...Benthic Flora, Mapping, Population Dynamics, Red Sea, ...**5.0891**

BIOLOGICAL SOUND ...Behavior, Sound Production, ...**1.0064**

SYSTEMATICS, BIOLOGY, AND HYDROGRAPHIC RELATIONS OF SOME SPECIES OF CALANUS (CRUSTACEA, COPEPODA) ...Animal Taxonomy, Copepods, Invertebrate Anatomy, Oceanic Fronts, Vertical Distribution, ...**5.0367**

STUDIES ON THE SPORT FISHERY FOR BILLFISHES AND TUNAS IN THE WESTERN ATLANTIC AND SOUTHEASTERN PACIFIC OCEAN. ...Atlantic Ocean-general, Fishing, Pacific Ocean-general, Swordfish, Tuna, Mackerel, Albacore... , ...**5.0069**

INVESTIGATE THE CAUSE OF MORTALITY OF PACIFIC OYSTERS ALONG THE CALIFORNIA COAST ...California, Environmental Ecology, Mortality Rates, Oysters, Pathology, Training Grants, Fellowships, ...**5.0360**

ECOLOGICAL INVESTIGATIONS OF SOME COMMON MARINE FISHES OFF THE MEDITERRANEAN COAST OF ISRAEL ...Fish -non-specific, Mediterranean Sea-general, Population Dynamics, Productivity - Food Chain, Range Or Territorial Distr. , ...**5.0089**

TAXONOMY AND DISTRIBUTION OF CLUPEOIDS AND REVISION OF THE GENUS ILISHA OF THE FAMILY CLUPEIDAE ...Alewife,menhaden,shad,herring, Animal Taxonomy, Handbooks, Indian Ocean-general, Nomenclature, Classification, Range Or Territorial Distr. , ...**5.0088**

LOCATION OF INSHORE SPAWNING AREAS ...Bluefish, Long Island Sound, Nets, Spawning & Nesting Sites, Water Temperature-non-specific, ...**5.0201**

INTRODUCTION OF MARINE GAME FISHES FROM AREAS IN THE PACIFIC ...Diving and Scuba, Hawaii, Pacific Ocean-north, Stocking of Fish & Shellfish, ...**5.0075**

SEA SLED AND SCUBA RECONNAISSANCE OF INSHORE AND STUDIES ON EFFECT OF ARTIFICIAL SHELTERS ON STANDING CROP OF FISHES ...Coastlines-shorelines, Diving and Scuba, Fish -non-specific, Geomorphology-topography, Hawaii, Management -other, ...**9.0008**

ECOLOGICAL STUDIES OF ROCKY SUBTIDAL AREAS ...Animal Taxonomy, Habitat Studies, Marine Plants, Plant Taxonomy, ...**5.0865**

SPORT FISH BEHAVIORAL STUDIES ...Basses -sea,white, White Perch, Behavioral Ecology, Habitat Studies, Porgies, Rockfish, Scorpionfish, ...**5.0045**

SEA OTTER ...Alaska, Metamorphosis, Population Dynamics, Range Or Territorial Distr. , Sea Lions, Fur Seals, Stocking of Mammals, ...**5.0528**

INVENTORY OF LARVAL FISH ...Aquatic Ecology, Brackish Water, Fish -non-specific, Maturity & Growth Stages, ...**5.0071**

BREEDING AND MATERNAL BEHAVIOR AMONG THE STELLER SEA LION ...Behavior, Developmental Physiology, Parturition, Seals, Spawning & Nesting Sites, ...**5.0524**

INVESTIGATION OF ANADROMOUS DOLLY VARDEN POPULATIONS IN HOOD BAY DRAINAGES, SOUTHEASTERN ALASKA ...Alaska, Lake Trout, Brook Trout, Migration, Population Dynamics, Streams, ...**5.0013**

SPORTFISH YIELD OF NATURAL REEFS ...Bays, California, Fishery Development -other, Habitat Studies, Population Dynamics, ...**5.0199**

STUDY ON THE DISTRIBUTION AND ABUNDANCE OF PINK SHRIMP, PANDALUS JORDANI, IN THE PACIFIC OCEAN OFF OREGON ...Censusing, Fishing Gear, Life History Studies, Pacific Ocean-general, Population Dynamics, Shrimps - Common, ...**5.0487**

PRELIMINARY STUDY TO DETERMINE ABUNDANCE AND RECRUITMENT OF BOTTOMFISH OFF OREGON ...Nets, Number Or Density, Oregon, Pacific Ocean-general, Righteye Flounders, ...**5.0136**

CONTROLLED REARING OF DUNGENESS CRAB LARVAE ...Captive Rearing, Crabs, Developmental Physiology, Maturity & Growth Stages, Oregon, ...**5.0486**

INSPECTION OF OYSTER SEED - NEW ASIATIC SOURCES ...Captive Rearing, Commercial Fishing, Germ Free Animal, Japan, Oysters, ...**5.0511**

ESTIMATE OF STANDING CROP OF OYSTERS AND SURVEY OF OYSTER PREDATORS IN GEORGIA ...Censusing, Georgia, Oysters, Predation, ...**5.0416**

MARINE LABORATORY ...Fishing Gear, Laboratory Analysis, Louisiana, Nets, Organism Sampling Devices, Technique Development, ...**11.0024**

DESIGN AND CONSTRUCTION OF BARGE AND CLAM DREDGE FOR SURVEY OF FLORIDA'S COMMERCIAL CLAMS ...Clams, Commercial Fishing, Florida, Habitat Studies, Other-design-and-construction, ...**8.0284**

THE DETERMINATION OF THE AVAILABILITY OF SEA ROBINS ...Benthic Fauna, Chesapeake Bay, Fish -other, Nets, Vertical Distribution, ...**5.0152**

A STUDY OF THE SEASONAL ABUNDANCE, DISTRIBUTION AND SPECIES COMPOSITION, WITH DEPTH, OF NEKTON FAUNA, WITH PARTICULAR EMPHASIS ON FISHES ...Fish -non-specific, Life History Studies, Number Or Density, Vertical Distribution, Zooplankton, ...**5.0114**

MANAGEMENT INVESTIGATIONS OF TWO SPECIES OF SPINY LOBSTERS PANULIRUS JAPONICUS AND P. PENICILLATUS ...Captive Rearing, Commercial Fishing, Lobsters, Management -other, Tags, ...**5.0422**

SHELLFISH EMBRYOLOGY AND LARVAE DEVELOPMENT STUDY ...Basic Embryology, Captive Rearing, Crustacea -non-specific, Mollusks -non-specific & Other, Training Grants, Fellowships, ...**5.0358**

PORT SAMPLING - CRESENT CITY, BROOKINGS, PORT ORFORD ...Crabs, Fish -non-specific, Life History Studies, Nets, Shrimps - Common, ...**5.0356**

SEA SURVEY INVESTIGATIONS ...California Current, Fish -non-specific, Population Dynamics, Survey Studies, Vertical Distribution, ...**4.0117**

KING CRAB SAMPLING GEAR STUDY ...Alaska, Censusing, Crabs, Fishing Gear, Population Dynamics, Spawning & Nesting Sites, ...**8.0113**

SHELLFISH AND BOTTOMFISH DATA ...Commercial Fishing, Crabs, Fish -other, Legislation, Shrimps - Common, ...**5.0357**

EVALUATE THE RESEARCH TECHNIQUES WHICH WILL BE EMPLOYED TO STUDY THE BASIC LIFE HISTORY OF THE RED CRAB (GERYON QUINQUEDENS) ...Age, Crabs, Mark, Tag Or Capture -other, Maturity & Growth Stages, Size, ...**5.0494**

AQUISITION OF A SUITABLE PROTOTYPE FISHING VESSEL AND GEAR ...American Samoa, Commercial Fishing, Equipment Purchase Operation, Nets, Tuna, Mackerel, Albacore... , ...**12.0004**

COASTAL LOBSTER FISHERY ...Censusing, Commercial Fishing, Legislation, Lobsters, Massachusetts, ...**5.0452**

FOOD HABITS STUDY OF ORGANISMS OF THE CALIFORNIA CURRENT SYSTEM ...Behavioral Ecology, California, California Current, Food Supply, Pacific Ocean-general, ...**5.0044**

BRISTOL BAY INTERMEDIATE HIGH SEAS-INSHORE TEST FISHING ...Age, Alaska, Bays, Commercial Fishing, Salmon - coho,chinook,sockeye.., ...**5.0022**

OFFSHORE SALMON ABUNDANCE INDEX ...Alaska, Commercial Fishing, Number Or Density, Salmon -coho,chinook,sockeye.., Streams, ...**5.0028**

OPERATIONAL TESTING OF THE PELAGIC TRAWLS ON SMALL DRAGGERS ...Fishing Gear, Nets, ...**8.0144**

FISH POPULATIONS OF AMERICAN SAMOA ...American Samoa, Crustacea -non-specific, Fish -non-specific, Fishing Gear, Number Or Density, ...**5.0033**

GEAR EVALUATION ...American Samoa, Fish -non-specific, Fishing Gear, Nets, ...**8.0114**

KODIAK KING CRAB ENVIRONMENTAL ZONE SURVEY ...Alaska, Continental Shelf, Environmental Ecology, Horseshoe Or King Crabs, Reproductive System, ...**5.0348**

COLLECTION OF MATERIALS AND DATA FOR AGE-GROWTH ANALYSIS ...Age, Commercial Fishing, Fish -other, Growth Rate, ...**5.0330**

DEMONSTRATION OF THE LIMITATIONS AND EFFECTS OF WASTE DISPOSAL ON AN OCEAN SHELF ...Marine Plants, Ocean, Outlet, Pollution - Effects of , Pollution Effects, Sewers, ...**6.0146**

DISTRIBUTION OF LIFE WITH DEPTH ...Continental Shelf, Motion Pictures -non-specific, North Carolina, Photography, Vertical Distribution, ...**5.0885**

BIONOMICS OF FISHES AND SHELLFISHES ...Aquaculture & Fish-farming, Bays, Economics-general, Environmental Ecology, Oregon, Productivity - Food Chain, ...**5.0920**

MORPHOLOGY, PHYSIOLOGY AND ECOLOGY OF MARINE LAMELLIBRANCHS ...Aquatic Ecology, Basic Embryology, Behavior, Freshwater Mussels, Scallops, Invertebrate Anatomy, ...**5.0479**

THE INFLUENCE OF ENVIRONMENTAL FACTORS UPON DEVELOPING MERISTIC STRUCTURES IN THE MARINE FISH, FUNDULUS MAJALIS (WALBAUM) ...Basic Embryology, Developmental Physiology, Environmental Physiology, Killifishs - Cyprinodon, Water Temperature-non-specific, ...**5.0298**

COLLECTION AND SURVEY OF NORTH CAROLINA MARINE AND ESTUARINE MOLLUSCA ...Collections, Estuaries, Mollusks -non-specific & Other, North Carolina, Survey Studies, ...**5.0480**

CRUSTACEAN COLLECTION OF EAST COAST OF UNITED STATES ...Atlantic Ocean-north, Collections, Crustacea -non-specific, Estuaries, North Carolina, ...**5.0481**

SYSTEMATICS, ZOOGEOGRAPHY, AND ECOLOGY OF ELASMOBRANCHS OF THE WESTERN ATLANTIC OCEAN ...Animal Taxonomy, Aquatic Ecology, Atlantic Ocean-general, Chondrichthyes -other, Nearctic, ...**5.0132**

FISH COLLECTION OF NORTH CAROLINA AND WESTERN ATLANTIC FISHES ...Atlantic Ocean-north, Collections, Fish -non-specific, Fresh Water, North Carolina, ...**5.0133**

A HISTOCHEMICAL STUDY OF THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Cholinesterase, Histochemistry - Cytochem, Horseshoe Or King Crabs, Nervous System, Organelle-enzyme Assn, ...**5.1000**

REFERENCE COLLECTION OF GULF MARINE ANIMALS ...Animal Taxonomy, Collections, Gulf of Mexico, Invertebrates -non-specific, Vertebrates -non-specific, ...**5.0657**

STUDY OF LIFE HISTORY AND ECOLOGY OF SERPULIDAE IN TEXAS COASTAL WATERS ...Gulf of Mexico, Life History Studies, Lugworms, Marine Segmentedworm, Texas, ...**5.0656**

ECOLOGY OF MARSH FORAMINIFERA ...Foraminifera, Lagoons, Productivity - Food Chain, Rate of Deposition, Swamps-marshes, ...**5.0747**

CILIA DIFFERENTIATION IN MARINE EMBRYOS ...Basic Embryology, Cilia and Flagella, Lugworms, Marine Segmentedworm, Sea Urchins & Other Echinoderm, ...**5.0617**

SYSTEMATICS MORPHOLOGY AND ECOLOGY OF THE GENUS ERVILIA (MOLLUSCA: PELECYPODA) IN THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean-general, Ecology (animal), Freshwater Mussels, Scallops, Invertebrate Anatomy, ...**5.0458**

PHYSIOLOGICAL VARIATION IN SUBTIDAL AND INTERTIDAL MARINE INVERTEBRATES ...Habitat Studies, Intertidal Areas, Invertebrates -non-specific, ...**5.0548**

THE MORPHOLOGY, HISTOCHEMISTRY, AND MODE OF SECRETION IN THE VENOM GLAND OF SEA SNAKES ...Endocrine -other, Histochemistry - Cytochem, Snakes, Venom, Vertebrate Anatomy, ...**5.0529**

INVESTIGATIONS OF THE INDUCING CAPACITY OF THE POLAR LOBE IN THE DEVELOPMENT OF THE MARINE GASTROPOD ILYANASSA OBSOLETA ...Developmental Physiology, Gastropods -slugs,conch,snails, Invertebrate Physiology, ...**5.0417**

THE EPICARIDEA OF THE EASTERN PACIFIC ...Animal Taxonomy, Isopods, Pacific Ocean-east, ...**5.0353**

SHALLOW WATER MEIOBENTHOS OF THE BERMUDA PLATFORM ...Benthic Fauna, Benthonic-bottom, Bermuda, Continental Shelf, ...**5.0649**

THE POPULATION ECOLOGY OF GEMMA GEMMA (PELECYPODA, VENERIDAE), A DOMINANT SPECIES IN BARNSTABLE HARBOR, MASS ...Clams, Harbors, Massachusetts, Population Dynamics, ...**5.0460**

ENERGY AND ELEMENT TRANSFER IN LOWER MARINE TROPHIC LEVELS ...Copepods, Energy Budgets, Oregon, Phytoplankton, ...**5.0823**

THE ROLE OF FECAL PELLETS IN MARINE FOOD CHAINS ...Feces, ...**5.0964**

OREGON FISHES - THEIR CLASSIFICATIONS, DISTRIBUTIONS AND LIFE HISTORIES ...Animal Taxonomy, Fresh Water, Life History Studies, Oregon, Vertical Distribution, ...**5.0137**

OREGON FISHES - THEIR CLASSIFICATION, DISTRIBUTION AND BIOLOGY ...Animal Taxonomy, Fish -non-specific, Fresh Water, Oregon, Vertical Distribution, ...**5.0138**

EARLY LIFE OF BOREAL FOOD FISH AND SHELLFISH ...Animal Taxonomy, Fish -non-specific, Life History Studies, Mollusks -non-specific & Other, Mortality Rates, ...**5.0139**

ALBACORE TUNA ...Behavioral Ecology, Environmental Ecology, Life History Studies, Tags, Tuna, Mackerel, Albacore... , ...**5.0143**

FISH GENETICS AND ECOLOGY ...DNA Other, Estuaries, Fish -non-specific, Life History Studies, ...**5.0309**

FINANCING OF FISHING VESSELS ...Commercial Fishing, Economics, Fish & Shellfish, Rhode Island, Savings and Investment, ...**4.0185**

REAR AND DESCRIBE LARVAE OF BIVALVES ...Captive Rearing, Clams, Developmental Physiology, Freshwater Mussels, Scallops, Invertebrate Culture, ...**5.0507**

ALGAE AS FOOD FOR MARINE INVERTEBRATE LARVAE HELD IN THE LABORATORY ...Algal Culture, Bulk Culture -other, Chesapeake Bay, Invertebrate Nutrition, Invertebrates -non-specific, ...**5.0732**

ULTRASTRUCTURAL STUDIES OF PARASITIC AND SAPROPHYTIC FUNGI AND PROTOZOA ASSOCIATED WITH MARINE INVERTEBRATES ...Cell Cycle, Electron Microscopy, Host-parasite Interactions, Myxomycetes, Protozoa, ...**5.0839**

BENTHIC MARINE FAUNA OF THE UPPER SHELF OFF VIRGINIA ...Animal Taxonomy, Benthic Fauna, Benthonic-bottom, Continental Shelf, Organism Sampling Devices, Virginia, ...**5.0660**

BIOCHEMICAL AND BIOPHYSICAL STUDIES OF THE MARINE ENVIRONMENT ...Copepods, Energy, Energy Budgets, Organics, Productivity - Food Chain, ...**5.0767**

SYSTEMATICS AND ZOOGEOGRAPHY OF THE BLENNIOID FISHES ...Animal Taxonomy, Bone, Fish -other, Nomenclature, Classification, World Wide, ...**5.0051**

THE TAXONOMY AND ZOOGEOGRAPHY OF THE POLYCHAETOUS ANNELIDS OF THE GULF OF MEXICO AND THE CARIBBEAN SEA ...Animal Taxonomy, Caribbean Sea, Gulf of Mexico, Lugworms, Marine Segmentedworm, Neotropical, ...**5.0569**

SYSTEMATIC REVISION OF THE FAMILY PERIPLOMATIDAE ...Animal Taxonomy, Freshwater Mussels, Scallops, Nomenclature, Classification, ...**5.0401**

STUDY OF NORTH AND EQUATORIAL ATLANTIC PLANKTONIC FORAMINIFERA ...Foraminifera, Number Or Density, Oceanic Fronts, Organism Sampling Devices, Vertical Distribution, ...**5.0764**

THE TAXONOMY AND ZOOGEOGRAPHY OF THE MAGELONIDAE OF THE WORLD ...Animal Taxonomy, Collections, Lugworms, Marine Segmentedworm, Nomenclature, Classification, World Wide, ...**5.0570**

DISTRIBUTION MAPS OF ANTARCTIC HOLOTHURIANS AND ECHINOIDS - ECHINODERMAT ...Charts, Environmental Ecology, Sea Cucumber, Sea Urchins & Other Echinoderm, Vertical Distribution, ...**5.0573**

MARINE POLYCHAETE WORMS OF THE NEW ENGLAND REGION (GULF OF ST. LAWRENCE TO CHESAPEAKE BAY) ...Animal Taxonomy, Lugworms, Marine Segmentedworm, Nomenclature, Classification, Northeast, Vertical Distribution, ...**5.0574**

MARINE POLYCHAETE WORMS OFF THE COLUMBIA RIVER, OREGON ...Animal Taxonomy, Collections, Lugworms, Marine Segmentedworm, Marine Biology, ...**5.0575**

SYSTEMATICS AND BIOLOGY OF EPIPELAGIC AND BATHYPELAGIC FISHES ...Animal Taxonomy, Atlantic Ocean-north, Fish -other, Indian Ocean-general, Vertebrate Anatomy, Vertical Distribution, ...**5.0049**

MARINE NEMATODES OF THE CAPE COD AREA ...Animal Taxonomy, Collections, Habitat Studies, Nematoda -other, Northeast, ...**5.0566**

COMPARATIVE MORPHOLOGY OF MARINE NEMATODES ...Comparative Physiology, Histology and Cytology, Invertebrate Anatomy, Musculoskeletal System, Nematoda -other, ...**5.0567**

A BIBLIOGRAPHY OF THE MARINE MOLLUSKS OF THE INDO-PACIFIC REGION ...Animal Taxonomy, Asia, Bibliography, Computer Methods -general, Mollusks -non-specific & Other, ...**5.0398**

HYPERIID AMPHIPODS FROM THE GULF OF GUINEA ...Animal Taxonomy, Collections, Guinea, Oceanography-general, Shrimp - Amphipods, Vertical Distribution, ...**5.0387**

SYSTEMATICS AND ECOLOGY OF MARINE BIRDS ...Animal Taxonomy, Handbooks, Range Or Territorial Distr. , Shorebirds-gulls,terns,skimmer, World Wide, ...**5.0582**

MOVEMENTS OF SEABIRDS IN THE HUMBOLDT CURRENT ...Aves -other, Biological Rhythms, Humboldt Or Peru Current, Population Dynamics, Temporal Distribution, ...**5.0583**

BIOLOGY, MORPHOLOGY, AND EVOLUTION OF THE DISK-FISHES OR SHARKSUCKERS ...Animal Taxonomy, Ethological, Fish -other, Host Specificity, Vertebrate Anatomy, ...**5.0250**

PACIFIC OCEAN BIOLOGICAL SURVEY PROGRAM ...Birds -non-specific, Islands, Meteorological Studies, Pacific Ocean-general, Vertical Distribution, ...**5.0568**

AUTOMATIC DATA PROCESSING - SEABIRD DISTRIBUTION ...Birds -non-specific, Computer Methods -general, Nomenclature, Classification, Range Or Territorial Distr. , World Wide, ...**4.0020**

COPEPODS PARASITIC ON SHARKS OF THE WEST COAST OF FLORIDA ...Animal Taxonomy, Copepods, Ectoparasites, Florida, Sharks, ...**5.0391**

OSTRACODA OF THE INDIAN OCEAN ...Animal Taxonomy, Biogenous, Indian Ocean-general, Quaternary Period, Shrimps - Seed Or Mussel, ...**5.0385**

ABYSSAL OSTRACODES OF THE WORLD ...Abyssal, Core Analysis, Shrimps - Seed Or Mussel, Vertical Distribution, World Wide, ...**5.0386**

REPRODUCTIVE ISOLATING MECHANISMS IN PANAMANIAN INSHORE MARINE FISHES ...Behavioral Ecology, Comparative Physiology, Fish -non-specific, Panama, Reproduction Studies (general), ...**5.0244**

THE BIOLOGY OF ROCK-BORING SIPUNCULIDS ...Caribbean Sea, Invertebrate Nutrition, Invertebrate Physiology, Invertebrates -non-specific, Reefs, ...**5.0577**

SYSTEMATICS OF ANTARCTIC SIPUNCULIDS AND ECHIURIDS COLLECTED BY THE ELTANIN EXPEDITION ...Animal Taxonomy, Antarctica, Collections, Expeditions, Invertebrates -non-specific, ...**5.0578**

REPRODUCTIVE BIOLOGY, DEVELOPMENT, AND SYSTEMATICS OF THE SIPUNCULIDS OF THE CARIBBEAN ...Animal Taxonomy, Caribbean Sea, Developmental Physiology, Invertebrates -non-specific, Range Or Territorial Distr. , Reproductive System, ...**5.0579**

THE CEPHALOPODS OF THE CENTRAL PACIFIC ...Number Or Density, Octopus, Squid, Cuttlefish... , Vertical Distribution, ...**5.0399**

SYSTEMATIC STUDIES ON MOLLUSKS FROM WALTERS SHOALS, INDIAN OCEAN ...Animal Taxonomy, Collections, Ethiopian, Indian Ocean-general, Mollusks -non-specific & Other, ...**5.0402**

SYSTEMATICS AND MORPHOLOGY OF THE SIPUNCULID LARVAE OF THE INDIAN OCEAN ...Animal Taxonomy, Developmental Physiology, Indian Ocean-general, Invertebrate Anatomy, Invertebrates -non-specific, ...**5.0765**

STOMATOPOD CRUSTACEA FROM THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean-general, Shrimps - Mantis... , ...**5.0395**

THE SYSTEMATICS AND DISTRIBUTION OF THE WORLD-WIDE SQUID FAMILY BATHYTEUTHIDAE ...Animal Taxonomy, Life History Studies, Number Or Density, Octopus, Squid, Cuttlefish... , World Wide, ...**5.0400**

LIFE HISTORY OF THE SHARK COPEPOD, KROYERIA DISPAR ...Copepods, Developmental Physiology, Ectoparasites, Life History Studies, Whole Body Culture & Rearing, ...**5.0393**

ABYSSAL AND BATHYAL SYNOPIIDAE OF WORLD ...Abyssal, Animal Taxonomy, Bathyal, Crustacea -non-specific, Vertical Distribution, World Wide, ...**5.0384**

SYSTEMATIC STUDY OF MYODOCOPID OSTRACODS OF THE INDIAN OCEAN ...Animal Taxonomy, Collections, Expeditions, Indian Ocean-general, Shrimps - Seed Or Mussel, ...**5.0394**

NEPHROPID LOBSTERS OF THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean-north, Collections, Lobsters, ...**5.0396**

STOMATOPOD CRUSTACEA OF THE EASTERN PACIFIC REGION ...Animal Taxonomy, Atlantic Ocean-general, Pacific Ocean-east, Shrimps - Mantis... , ...**5.0397**

SYSTEMATIC REVISION PLATYCEPHALIDAE (PISCES) ...Classical, Fish -other, Indian Ocean-general, Museum, Nomenclature, Classification, ...**5.0050**

STUDIES OF FISH FAMILIES ARIIDAE AND ASPREDINIDAE ...Animal Taxonomy, Fish -other, Interbiotic Relat.(non-specif), Neotropical, Tropic, ...**5.0052**

RESEARCH ON MINERAL STRUCTURE REVEALED BY AN ELECTRON MICROSCOPE ...Comparative Anatomy, Electron Microscopy, Geologic, Mineralogy, Paleontology, ...**7.0062**

ELASMOBRANCH PHARMACOLOGY ...Drug Evaluation, Mechanism of Action, Neuroeffective, Sharks, ...**6.0118**

STUDIES OF SHARK REPELLENTS AND OTHER ANTI-SHARK MEASURES ...Fish Repellents, Shark Repellents, Sharks, ...**6.0132**

ACTIVE CHEMICAL PRINCIPLES DERIVED FROM ECHINODERMS ...Chemoreceptors, Holothurin, Marine Plants, Toxicology, ...**6.0117**

BIOLOGICAL OCEANOGRAPHY ...Acoustical, Atlantic Ocean-north, Marine Biology, Sound Production, Submersibles, ...**1.0022**

MARINE ANIMAL TOXINS ...Fish Repellents, Mechanism of Action, Sharks, Toxins, ...**6.0116**

STUDY OF FISH MUCUS BIOCHEMISTRY ...Fish -non-specific, Locomotion -animal, Mucus, ...**8.0172**

GLOBAL VOLUME REVERBERATION LIMITATION STUDIES ...Acoustical, Atlantic Ocean-north, Reverberation, Scattering, Sound Production, ...**1.0037**

BIOLOGICAL FALSE TARGETS AND RELATED ACOUSTIC CHARACTERISTICS ...Animal Taxonomy, Behavioral Ecology, Fish -non-specific, Sound Production, ...**1.0041**

OCEAN WATER INTRUSION INTO BACK BAY, VIRGINIA, & CURRITUCK SOUND, NORTH CAROLINA, ON THE WATERFOWL & FRESHWATER FISH HABITAT ...Habitat Studies, North Carolina, Virginia, Water Salinity, Waterfowl - non-specific, ...**5.0897**

MIGRATORY HABITS OF LARGE SHARKS ...Atlantic Ocean-north, Fishing, Migration, Sharks, Tags, ...**5.0147**

EFFECT OF EURASIAN WATERMILFOIL CONTROL PROCEDURES ON WILDLIFE AND OTHER ORGANISMS IN AQUATIC ENVIRONMENTS ...Contamination - Water, Diquat, Evaluation, Water Milfoil, Waterweed... , 2,4-d, ...**5.0700**

AGE DETERMINATION OF LARGE ATLANTIC SHARKS ...Age, Atlantic Ocean-north, Growth Rate, ...**5.1028**

DISTRIBUTION OF YOUNG STAGES OF COASTAL FISHES ...Continental Shelf, Estuaries, Fish -non-specific, Maturity & Growth Stages, Number Or Density, Ships and Cruises, ...**5.0119**

INFLUENCE OF THE PHYSICAL ENVIRONMENT ON DISTRIBUTION OF YOUNG STAGES OF COASTAL GAME FISH ...Continental Shelf, Environmental Ecology, Fish -non-specific, Maturity & Growth Stages, Physical-general, Range Or Territorial Distr. , ...**5.0211**

INVENTORY AND ATLAS OF GULF COAST SPORT FISHING FACILITIES ...Atlases-maps, Fishing, Gulf of Mexico, Handbooks, Management -other, ...**9.0006**

EXPLORATORY COLLECTION AND CARE OF AQUATIC INVERTEBRATES FOR TESTING AT TIBURON ...Bioassay, Brackish Water, Captive Rearing, Invertebrates -non-specific, Pesticides -non-specific, ...**5.0905**

INVENTORY AND ATLAS OF MARINE SPORT-FISHING FACILITIES ...Atlantic Ocean-north, Eastern, Fishing, Handbooks, Recreation Sites, ...**9.0012**

LIFE HISTORY OF BILLFISHES ...California, Censusing, Life History Studies, Marlin, Billfishes, Sailfish.., Mexico, ...**5.0195**

TEMPERATURE TOLERANCE OF MARINE ANIMALS THROUGH BEHAVORIAL RESPONSES ...Behavior, Environment Resistance, Mortality Rates, Thermal, Water Temperature-non-specific, ...**5.0118**

THERMAL PREFERENCES OF MARINE FISHES AND INVERTEBRATES ...Behavior, Fish -non-specific, Invertebrates - non-specific, Thermal, Water Temperature-non-specific, ...**5.0209**

EFFECTS OF HOT WATER MASSES ON MARINE FISHES ...Atlantic Ocean-north, Behavior, Fish -non-specific, High Temp. -85f Or Above, Oceanic Fronts, Thermal, ...**5.0210**

ENVIRONMENTAL EFFECTS ON ISTIOPHORID FISH DISTRIBUTION ...Environmental Ecology, Gulf of Mexico, Marlin, Billfishes, Sailfish.., Ships and Cruises, Temporal Distribution, ...**5.0070**

SAN PABLO BAY STUDY ...Bays, Benthic Fauna, Bottom Sampling Device, Excavation, Pollution - Effects of , Spoil Banks, ...**6.0136**

LIFE HISTORY AND BEHAVIOR OF FISHES ON ARTIFICAL REEFS ...Behavioral Ecology, Fish -non-specific, Habitat Studies, Life History Studies, Population Dynamics, ...**5.0121**

HYDROGRAPHY, SEDIMENTATION AND CHEMICAL ASPECTS OF THE REEF ENVIRONMENT ...Aquatic Soils, Currents-ocean, Environmental Ecology, Fish -non-specific, Reefs, ...**5.0212**

DESIGN, CONSTRUCTION AND LONGEVITY OF ARTIFICIAL FISHING REEFS ...Atlantic Ocean-north, Currents-ocean, Reefs, Tides, ...**9.0013**

TAXONOMIC STUDIES ...Animal Taxonomy, Fish -other, Nomenclature, Classification, Pacific Ocean-east, ...**5.0034**

THE ROLE OF THE SENORITA, OXYJULIS CALIFORNICA, AS A CLEANING ORGANISM ...California, Ectoparasites, Fish -other, Fishery Development -other, Interbiotic Relat.(non-specif), ...**5.0193**

SAND DOLLAR COMMUNITIES ...Beaches, California, Habitat Studies, Productivity - Food Chain, Sea Urchins & Other Echinoderm, ...**5.0533**

1965 SALT-WATER ANGLING SURVEY ...Animal Taxonomy, Censusing, Fish -non-specific, Fishing, ...**9.0011**

TRACKING MIGRATIONS OF BLUEFISH POPULATIONS ALONG ATLANTIC COAST TO LEARN BIOLOGY OF THE SPECIES (MIGRATORY HABITS OF BLUEFISH) ...Atlantic Ocean-north, Bluefish, Migration, Population Dynamics, Tags, ...**5.0120**

EFFECT OF TEMPERATURES AND CIRCULATION OF CONTINENTAL SHELF WATERS ON THE DISTRIBUTION OF FISHES ...Continental Shelf, Fish -non-specific, Surface Environments, Temperature, Water Movement, Currents,, Water Temperature-non-specific, ...**4.0165**

PACIFIC COASTAL ENVIRONMENT AS RELATED TO DISTRIBUTION AND ABUNDANCE OF GAME SPECIES -- SEA SURFACE TEMPERATURE MEASUREMENTS ...Aquatic Ecology, California, Spectral Reflectance, Temperature, ...**1.0175**

TAGGING PROGRAM WITH WOODS HOLE AND INTERNATIONAL GAME FISH ASSOCIATION FOR MARLIN, SAILFISH AND OTHER GAME SPECIES MIGRATION STUDIES ...Marlin, Billfishes, Sailfish.., Migration, Pacific Ocean-general, Population Dynamics, Tags, ...**5.0036**

HYPOTHETICAL DISTRIBUTION OF 14 SPECIES OF ATLANTIC COASTAL GAME FISHES ...Aquatic Ecology, Atlantic Ocean-general, Environmental Ecology, Fish -other, Water Temperature-non-specific, ...**5.0123**

AGE AND GROWTH OF BLUEFISH ...Age, Atlantic Ocean-north, Bluefish, Growth Rate, Population Dynamics, Scales, ...**5.0287**

UPGRADING CONVENTIONAL FISHING TECHNIQUES ...Commercial Fishing, Fishing Gear, Nets, Pacific Ocean-north, Sonar, Telemetry, ...**8.0150**

ATLAS OF MARINE FAUNA ...Atlantic Ocean-north, Crustacea -non-specific, Fish -non-specific, Handbooks, Mollusks -non-specific & Other, ...**5.0101**

PELAGIC FISH EXPLORATIONS ...Codfishes, Hake, Commercial Fishing, Fish -other, Nets, Vertical Distribution, ...**5.0172**

BOTTOMFISH EXPLORATIONS ...Commercial Fishing, Fish - other, Nets, Pacific Ocean-east, Vertical Distribution, ...**5.0168**

IMMUNOLOGY AND SEROLOGY OF MARINE ANIMALS ...Agglutination Tests, Biochemical Analysis, Blood Plasma and Serum, Immunology, Pathology, ...**5.0977**

ZOOPLANKTON OF THE GULF OF MAINE ...Atlantic Ocean-north, Plankton Sampling, Population Dynamics, Vertical Distribution, Zooplankton, ...**5.0789**

ABUNDANCE AND AVAILABILITY OF PRE-RECRUIT HERRING ...Alewife,menhaden,shad,herring, Aquatic Ecology, Environmental Ecology, Life History Studies, Number Or Density, Vertical Distribution, ...**5.0208**

SAMPLING OF THE ATLANTIC COMMERCIAL CATCH ...Alewife,menhaden,shad,herring, Atlantic Ocean-general, Commercial Fishing, Nets, Number Or Density, ...**5.0129**

POPULATION STUDIES ...Alewife,menhaden,shad,herring, Animal Distr. (non-specific), Animal Taxonomy, Environmental Ecology, Population Dynamics, ...**5.0130**

ACCUMULATION OF RADIOACTIVITY BY INVERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Contamination - Water, Cooperative-studies, Diagnostic Procedures, Radioactivity-general, Reactor Sites & Rad Waste, ...**5.0474**

ACCUMULATION OF RADIONUCLIDES BY VERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Biological, Contamination - Water, Estuaries, Radioactivity-general, ...**5.0293**

ACCUMULATION OF RADIOACTIVITY BY ORGANISMS IN EXPERIMENTAL MARINE ENVIRONMENTS ...Contamination - Water, Cooperative-studies, Estuaries, Laboratory, Radioactivity, ...**5.0911**

THE EFFECTS OF RADIATION ON THE PHYSIOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Cooperative-studies, Radioactive Fallout, ...**5.0294**

THE EFFECTS OF RADIATION ON THE MORPHOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Cooperative-studies, Fish -other, Radiation Sensitivity-, Vertebrate Anatomy, Vertebrates Excl. man, ...**5.0295**

GULF-PENINSULA KING CRAB STUDIES ...Commercial Fishing, Crabs, Gulf of Alaska, Habitat Studies, Population Dynamics, ...**5.0342**

MARINE BIOLOGICAL INVESTIGATIONS - TAXONOMIC COLLECTION OF THE FRESH AND SALTWATER FISHES OF ALASKA ...Alaska, Animal Taxonomy, Collections, Fish - non-specific, Fresh Water, ...**5.0008**

GULF OF ALASKA DEMERSAL FISH INVESTIGATIONS ...Fish -non-specific, Gulf of Alaska, Population Dynamics, Productivity (agricultural), Vertical Distribution, ...**5.0009**

MARINE BIOLOGICAL INVESTIGATIONS - NEKTON OF INSIDE WATERS OF SOUTHEASTERN ALASKA ...Alaska, Plankton Sampling, Population Dynamics, Temporal Distribution, Zooplankton, ...**5.0521**

MARINE BIOLOGICAL INVESTIGATIONS - ANALYSIS OF HERRING FISHERY DATA ...Age, Alaska, Alewife,menhaden,shad,herring, Data Analysis - General, Dispersion -other, ...**5.0010**

FUR SEAL RESEARCH, PELAGIC INVESTIGATIONS ...Behavioral Ecology, Food Supply, Seals, Vertical Distribution, ...**5.0667**

EFFECTS OF CHEMICALS ON THE PHYSIOLOGY OF SEA LAMPREY AMMOCETES (PETROMYZON MARINUS) ...Contamination - Water, Control of Nuisance Species, Environmental Physiology, Lampreys, Maturity & Growth Stages, ...**5.0631**

TAXONOMIC REVISION OF BATHYLAGIDAE ...Animal Taxonomy, Deepsea Smelts, Tables, Compilations, Catalogs, Temperate, Tropic, ...**5.0055**

STUDIES ON ANACANTHINE FISHES ...Animal Taxonomy, Atlantic Ocean-north, Continental Shelf, Fish -other, Pubilications -other, ...**5.0048**

SYSTEMATIC STUDIES ON THE FAMILY SCOMBRIDAE ...Animal Taxonomy, Indian Ocean-general, Nomenclature, Classification, Tuna, Mackerel, Albacore... , Vertebrate Anatomy, ...**5.0056**

POPULATION DYNAMICS OF NEW ENGLAND GROUNDFISH ...Atlantic Ocean-north, Codfishes, Hake, Lefteye Flounders, Population Dynamics, Rockfish, Scoraionfish, ...**5.0103**

INVESTIGATE SYSTEMATICS AND ECOLOGY OF TUNA LARVAE AND JUVENILES ...Animal Taxonomy, Artifical Insemination, Maturity & Growth Stages, Spawning & Nesting Sites, Tuna, Mackerel, Albacore... , ...**5.0079**

INVESTIGATE SEASONAL VARIATIONS, SURFACE WATER TYPES, HAWAIIAN AREA (KOKO HEAD) ...Commercial Fishing, Hawaii, Heat and Radiation Transfer, Oceanic Fronts, Salinity, Temperature, Tuna, Mackerel, Albacore... , Water Salinity, Water Temperature-non-specific, ...**1.0148**

FISHES TAKEN INCIDENTAL TO SHRIMP TRAWLING ...Atlantic Ocean-south, Fish -non-specific, Nets, Number Or Density, Shrimps - Common, ...**5.0072**

SYSTEMATIC STUDIES OF FISHES ...Animal Taxonomy, Developmental Physiology, Fish -non-specific, Life History Studies, Vertebrate Anatomy, ...**5.0059**

IDENTIFICATION AND DESCRIPTION OF FISH LARVAE ...Animal Taxonomy, Atlantic Ocean-north, Fish -non-specific, Life History Studies, Southern, ...**5.0074**

REPRODUCTION AND FECUNDITY OF TUNAS ...Behavior, Biological Rhythms, Female Gametes, Fertility, Tuna, Mackerel, Albacore... , ...**4.0159**

DISTRIBUTION AND ECOLOGY OF ATLANTIC TUNAS ...Atlantic Ocean-general, Environmental Ecology, Range Or Territorial Distr. , Temporal Distribution, Tuna, Mackerel, Albacore... , ...**5.0063**

MIGRATION OF ATLANTIC TUNAS ...Africa, Atlantic Ocean-general, Migration, Tags, Tuna, Mackerel, Albacore... , ...**5.0064**

FEEDING HABITS OF ATLANTIC TUNAS AND NEKTON ECOLOGY ...Atlantic Ocean-general, Food Supply, Plankton (non-specific), Productivity - Food Chain, Tuna, Mackerel, Albacore... , ...**5.0204**

POPULATION DYNAMICS OF ATLANTIC TUNAS ...Atlantic Ocean-general, Censusing, Commercial Fishing, Population Dynamics, Tuna, Mackerel, Albacore... , ...**5.0065**

INTERRELATIONS WITHIN THE PHYSICAL ENVIRONMENT ...Commercial Fishing, Density, Environmental Ecology, Sea Level Variations, Temporal Distribution, ...**2.0078**

MONITORING SURVEY AND TIME-SERIES ANALYSIS OF SUBSURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN ...Pacific Ocean-north, Subsurface Environments, Temperature, Thermocline, Water Temperature-non-specific, ...**1.0176**

MECHANISMS AFFECTING THE VERTICAL AND HORIZONTAL DISTRIBUTION OF TUNAS AND RELATED SPECIES ...Behavioral Ecology, Environmental Ecology, Mark, Tag Or Capture -other, Tuna, Mackerel, Albacore... , Vertical Distribution, ...**5.0087**

OCEAN ENGINEERING ...Bathymetry, Commercial Fishing, Fishing Gear, Instrumental Services, Telemetry-other, ...**8.0152**

FISHING GEAR RESEARCH AND DEVELOPMENT ...Commercial Fishing, Fishing Gear, Meetings, Nets, ...**8.0153**

SHELLFISH EXPLORATIONS ...Benthic Fauna, Clams, Commercial Fishing, Mark, Tag Or Capture -other, Population Dynamics, ...**5.0514**

MARINE FISH BEHAVIOR ...Behavioral Ecology, Commercial Fishing, Fish -non-specific, Fishing Gear, ...**5.0176**

BIOLOGICAL STUDIES OF NORTHWEST ATLANTIC GROUNDFISH ...Atlantic Ocean-north, Codfishes, Hake, Freshwater Mussels, Scallops, Righteye Flounders, Rockfish, Scoraionfish, ...**5.0104**

EXPLORATION OF LATENT RESOURCES ON THE CONTINENTAL SHELF/SLOPE ...Atlantic Ocean-north, Commercial Fishing, Continental Shelf, Nets, Survey Studies, ...**5.0102**

STUDIES OF THE BENTHIC INVERTEBRATES OF THE ATLANTIC CONTINENTAL SHELF ...Atlantic Ocean-north, Benthic Fauna, Continental Shelf, Population Dynamics, Productivity - Food Chain, ...**5.0623**

LOBSTER RESEARCH ...Commercial Fishing, Environmental Ecology, Habitat Studies, Lobsters, Population Dynamics, ...**5.0436**

MARINE BIOLOGICAL INVESTIGATIONS STUDIES PROJECT (FISHES) ...Alaska, Aquatic Ecology, Bays, Fish -non-specific, Population Dynamics, ...**5.0011**

MARINE BIOLOGICAL INVESTIGATIONS - SURFACE ZOOPLANKTON PROJECT ...Alaska, Number Or Density, Plankton Sampling, Vertical Distribution, Zooplankton, ...**5.0737**

MARINE BIOLOGICAL INVESTIGATIONS - JAPANESE FISHERY OBSERVERS PROJECT ...Commercial Fishing, Gulf of Alaska, Japan, Nets, Righteye Flounders, ...**5.0012**

BOTTOMFISH EXPLORATIONS ...Bering Sea, Fish -other, Gulf of Alaska, Nets, Vertical Distribution, ...**5.0030**

BERING SEA KING CRAB STUDIES ...Bering Sea, Commercial Fishing, Crabs, Environmental Ecology, Migration, ...**5.0341**

PINK SALMON INVESTIGATIONS - EARLY SEA LIFE OF SALMON ...Alaska, Environmental Physiology, Life History Studies, Parasitology -other, Water Temperature-non-specific, ...**5.0187**

COMPOSITION STUDIES OF FISH AND SHELLFISH AS RELATED TO STORAGE AND PROCESSING PROBLEMS ...Crabs, Fish -other, Freezing, Mackerel, Packaging, Rancidity, ...**6.0046**

CONTRIBUTIONS TO THE BIOLOGY OF THE ROYAL RED SHRIMP, HYMENOPENAEUS ROBUSTUS ...Atlantic Ocean-south, Maturity & Growth Stages, Number Or Density, Shrimps - Common, Vertical Distribution, ...**5.0421**

GROUNDFISH INVESTIGATIONS (POTENTIAL YIELD OF UNDERUTILIZED GROUNDFISH STOCKS) ...Codfishes, Hake, Commercial Fishing, Legislation, Number Or Density, Rockfish, Scoraionfish, ...**5.0171**

OCEAN GROWTH AND MORTALITY OF SALMON ...Growth Rate, Mortality Rates, Salmon -coho,chinook,sockeye.., Scales, Tags, ...**5.0170**

PACIFIC FISH PHYSIOLOGY AND BIOCHEMISTRY (SALMON IMMUNOCHEMISTRY) ...Immunology, Maturity & Growth Stages, Salmon -coho,chinook,sockeye.., Stress, ...**5.0332**

ANALYSIS OF JAPANESE CATCH STATISTICS ...Commercial Fishing, Japan, Number Or Density, Pacific Ocean-north, Salmon -coho,chinook,sockeye.., ...**5.0166**

POPULATION DYANMICS (BIOMETRICS) OF EXPLOITED FISH GROUPS OF THE NORTH PACIFIC OCEAN AND PACIFIC COAST ...Marine Biology, Meteorological Studies, Model Studies, Number Or Density, Pacific Ocean-north, Population Dynamics, ...**5.0167**

IDENTIFICATION OF SOCKEYE SALMON STOCKS BY BONE MINERALS ...Animal Taxonomy, Bone, Chemical Analysis, Pacific Ocean-general, Salmon -coho,chinook,sockeye.., ...**5.0333**

GULF OF ALASKA SOCKEYE SALMON SCALES, PROTOCOL AREA SOCKEYE SALMON SCALES, AND GULF OF ALASKA PINK SALMON SCALES ...Animal Taxonomy, Gulf of Alaska, Life History Studies, Salmon - coho,chinook,sockeye.., Scales, ...**5.0334**

ADMINISTRATION OF WHALING ACT - DEVELOPMENT OF RESEARCH TOOLS ...Age, Management -other, Mark, Tag Or Capture -other, ...**5.0670**

DESCRIPTIONS OF NEW SHARKS ...Animal Taxonomy, Collections, Nomenclature, Classification, Pubilications -other, Sharks, ...**5.0057**

A REVISION OF THE CAT SHARKS, SCYLIORHINIDAE ...Animal Taxonomy, Nomenclature, Classification, Sharks, Vertebrate Anatomy, ...**5.0058**

DIAGNOSTIC CHARACTERS & DEVELOPMENT OF EXTERNAL GENITALIA IN JUVENILE GROOVED SHRIMPS OF GENUS PENAEUS FROM WESTERN ATLANTIC ...Atlantic Ocean-general, Developmental Physiology, Invertebrate Anatomy, Reproductive System, Shrimps - Common, ...**5.0405**

CIRCULATION DYNAMICS (GULF OCEANOGRAPHY PROGRAM) ...Circulation-general, Environmental Changes, Gulf of Mexico, Shrimps - Common, Thermodynamics, ...**2.0045**

SPACE APPLICATIONS TO FISHERIES OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM) ...Commercial Fishing, Computer Applications, Forecasting-prediction, Satellites, Water Environment -other, ...**4.0172**

PREDICTING COMMERCIAL SHRIMP ABUNDANCE (SHRIMP DYNAMICS PROGRAM) ...Bays, Behavioral Ecology, Commercial Fishing, Environmental Ecology, Population Dynamics, Shrimps - Common, ...**5.0499**

BIOLOGICAL OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM) ...Environmental Ecology, Food Supply, Gulf of Mexico, Productivity - Food Chain, Shrimps - Common, ...**5.0838**

TAXONOMY AND BIOLOGY OF CLUPEOID FISHES ...Alewife,menhaden,shad,herring, Anchovies, Animal Taxonomy, Atlantic Ocean-general, Handbooks, ...**5.0060**

STOCK IDENTIFICATION OF ATLANTIC TUNAS ...Atlantic Ocean-general, Caribbean Sea, Electrophoresis -non-specific, Tuna, Mackerel, Albacore... , ...**5.0252**

INVESTIGATE TUNA SUBPOPULATIONS THROUGH THE USE OF BLOOD GROUPS AND INHERITED PROTEINS ...Blood Proteins -non-specific, Blood Typing Studies, Pacific Ocean-general, Population Dynamics, Tuna, Mackerel, Albacore... , ...**5.0076**

INCREASE EFFICIENCY OF HAWAIIAN SKIPJACK FISHERY ...Captive Rearing, Commercial Fishing, Food Supply, Hawaii, Tuna, Mackerel, Albacore... , ...**5.0077**

DEVELOP TECHNIQUES FOR CAPTURING JUVENILE TUNAS ...Blood Typing Studies, Nets, Population Dynamics, Tuna, Mackerel, Albacore... , Vertical Distribution, ...**5.0078**

DESCRIPTIVE PHYSICAL OCEANOGRAPHY OF THE EASTERN TROPICAL ATLANTIC ...Atlantic Ocean-general, Environmental Ecology, Fish -non-specific, Productivity - Food Chain, Tropic, ...**4.0127**

INVESTIGATE POPULATION DYNAMICS OF ALBACORE ...American Samoa, Commercial Fishing, Population Dynamics, Tuna, Mackerel, Albacore... , Water Environment -other, ...**5.0081**

ASSESSMENT OF CENTRAL PACIFIC TUNA RESOURCES ...Commercial Fishing, Pacific Ocean-general, Population Dynamics, Size, Tuna, Mackerel, Albacore... , ...**5.0082**

DEVELOP HIGH-SEAS TUNA FISHERY ...Commercial Fishing, Fishing Gear, Pacific Ocean-general, Tropic, Tuna, Mackerel, Albacore... , ...**5.0084**

DEVELOP FISHERIES FOR NON-TUNA RESOURCES ...Commercial Fishing, Fishing Gear, Hawaii, Pacific Ocean-general, Snappers, ...**5.0086**

FISHERY FORECASTING - TEMPERATE FISHERIES ...Circulation-general, General Synoptic Observations, Low Temp. -but Above 32f, Pacific Ocean-east, Temperature, ...**5.0197**

LOCAL FISHERY SYSTEMS DEVELOPMENT ...California, Commercial Fishing, Sharks, Shrimps - Common, Swordfish, ...**5.0198**

SCHOOLING BEHAVIOR ...Alewife,menhaden,shad,herring, Anchovies, Behavioral Ecology, Environmental Ecology, Tuna, Mackerel, Albacore... , ...**5.0038**

146 D EASTROPAC ...Marine Biology, Meteorological Studies, Pacific Ocean-east, Tropic, Tuna, Mackerel, Albacore... , Vertical Distribution, ...**4.0113**

INVESTIGATE POPULATION DYNAMICS OF SKIPJACK TUNA IN HAWAIIAN WATERS ...Commercial Fishing, Economics, Environmental Ecology, Hawaii, Population Dynamics, Tuna, Mackerel, Albacore... , ...**5.0083**

NORTHERN SHRIMP EXPLORATIONS ...Atlantic Ocean-north, Censusing, Commercial Fishing, Fishing Gear, Shrimps - Common, ...**5.0457**

THE OCEANOGRAPHY OF NEW ENGLAND FISHING BANKS ...Continental Shelf, Fish -other, Number Or Density, Vertical Distribution, Water Environment -other, ...**5.0901**

MICROBIOLOGY OF MARINE AND ESTUARINE INVERTEBRATES ...Estuaries, Marine Bacteria, Microbiological Analysis, Oysters, ...**5.0790**

PACIFIC OYSTER MORTALITY STUDIES ...Invertebrate Pathology, Mortality Rates, Oysters, Pacific Ocean-general, Pathology, ...**5.0442**

TUNA PURSE SEINE NET ...Commercial Fishing, Fishing Gear, Nets, Tuna, Mackerel, Albacore... , ...**8.0119**

PHYSIOLOGY OF MARINE ORGANISMS ...Energy, Environmental Physiology, Fish -non-specific, Food Supply, ...**5.0939**

FISH POPULATION PARAMETERS ...Age, Biological Rhythms, Life History Studies, Population Dynamics, Size, ...**5.0039**

REARING MARINE FISH ...Alewife,menhaden,shad,herring, Anchovies, Captive Rearing, Environmental Physiology, Tuna, Mackerel, Albacore... , ...**5.0041**

PRODUCTIVITY MEASURES ...Number Or Density, Ocean Currents-other, Organism Sampling Devices, Pacific Ocean-east, Primary Productivity, Productivity - Food Chain, Zooplankton, ...**5.0940**

CALIFORNIA CURRENT SURVEYS ...California Current, Environmental Ecology, Fish -non-specific, Pacific Ocean-east, Plankton (non-specific), ...**4.0114**

SUBPOPULATIONS ...Anchovies, Commercial Fishing, Pacific Ocean-general, Population Dynamics, ...**5.0042**

DEVELOPMENT OF FISHNET BATHYKMORGRAPH ...Commercial Fishing, Fishing Gear, Instrumental Services, Nets, Readout Systems, ...**8.0102**

FIELD STUDY - CAPE COD, MASS. ...Animal Distr. (non-specific), Benthonic-bottom, Buoys, Environmental Ecology, Sediments-other, Temperature, ...**5.0584**

HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE FISHES ...Contamination -

Water, Killifishs - Cyprinodon, Pathology, Pollution - Effects of , Pollution Effects, ...5.0323

HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE INVERTEBRATES ...Clams, Contamination - Water, Invertebrate Pathology, Pathology, Pollution - Effects of , Pollution Effects, Pollution Sources-other, ...5.0497

REARING AND SENSITIVITY STUDIES OF VARIOUS LIFE STAGES OF MARINE MACROINVERTEBRATES ...Bioindicators, Crabs, Shrimps - Common, Whole Body Culture & Rearing, ...5.0496

USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS ...Bioassays, Estuaries, Phytoplankton, Pollution - Effects of , Pollution Effects, Zooplankton, ...5.0832

DEVELOPMENT OF CULTURE METHODS FOR ECOLOGICALLY IMPORTANT MARINE ZOOPLANKTON SPECIES ...Aquatic Ecology, Copepods, Environmental Physiology, Invertebrate Culture, Zooplankton, ...5.0834

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON ...Copepods, Oxygen, Water Salinity, Water Temperature-non-specific, Zooplankton, ...5.0835

METABOLISM OF NEUROHUMORAL TRANSMITTER SUBSTANCES IN MARINE ANIMALS ...Animal Toxins, Basic Studies, Mech of Transmission, Metabolic Inhibitors, Structural Functions, ...5.0981

IONIC PERMEABILITIES OF THE SQUID GIANT AXON. - EFFECTS OF CHEMICAL AGENTS ...Cellular Physiology, Microelectrodes, Nervous System, Octopus, Squid, Cuttlefish... , Permeability, ...5.0979

FORMATION AND METABOLISM OF NEUROHUMORAL TRANSMITTER SUBSTANCES IN MARINE ANIMALS ...Basic Studies, Biochemical, Developmental Stages, Quantitative & Qualitative, Sharks, ...5.0980

BOTTOM FISH, FISH WASTE, SCRAP FISH & OTHER SEA PRODUCTS FOR FUR ANIMAL DIETS ...Alewife,menhaden,shad,herring, Antioxidants, Chubs, Notropis, Fish Meals, Management, Sea Lions, Fur Seals, ...6.0001

OCEANOGRAPHIC STUDY OF NORTHEASTERN U. S. COASTAL WATERS FOR INTERNATIONAL COMMISSION FOR NORTHWEST ATLANTIC FISHERIES ...Commercial Fishing, Gases, Salinity, Ships and Cruises, Temperature, ...4.0123

THE DISEASES OF INVERTEBRATE ANIMALS ...Developmental Physiology, Immumology, Invertebrate Pathology, Tumors, ...5.0536

IMMUNE MECHANISMS AND RESISTANCE FACTORS IN MARINE FISHES ...Antigen, Fish -other, Histochemical Test, Serology and Immunology, ...5.0255

PARASITES OF PHILIPPINE FISHES ...Animal Distr. (non-specific), Aquatic Ecology, Fish -non-specific, Helminths, Philippines, ...5.0251

THE COMPARATIVE IMMUNOLOGY OF LOWER ORGANISMS ...Blood Typing Studies, Comparative Physiology, Immumology, Serology and Immunology, ...5.0556

ENZYME STRUCTURE AND ITS RELATION TO TAXONOMY ...Animal Taxonomy, Conformational Studies, Echinodermata -other, Enzymes -non-specific, Species, ...5.0654

COLLECTION AND EXTRACTION OF MARINE INVERTEBRATES AND PLANTS ...Collections, Extracts, Lyophilization, Marine Plants, ...5.0697

CALCIFICATION MECHANISMS IN MARINE ORGANISMS ...Algae- General, Calcification, Marine Plants, Mollusks -non-specific & Other, ...5.1016

DEMINERALIZATION-BORING MECHANISMS OF MOLLUSKS ...Calcification, Gastropods -slugs,conch,snails, Invertebrate Anatomy, Invertebrate Physiology, Metabolism, ...5.0459

THE PROCESS OF DEMINERALIZATION-BORING IN BIVALVES ...Calcification, Derivatives, Freshwater Mussels, Scallops, Invertebrate Anatomy, Invertebrate Physiology, ...5.0366

STATOLITH DIFFERENTIATION IN AURELIA (JELLYFISH) ...Calcium, Developmental Physiology, Differentiation Mechanism, Jelly Fish, Proprioceptors, ...5.0598

PACIFIC BIOMEDICAL RESEARCH ...Buildings, Mycobacterium Leprae, Pacific Ocean-general, Pharmacognosy, ...6.0112

MARINE PHYSIOLOGY ...Cardiovascular System, Fish, Osmoregulation, Thermonegulation, Water Pressure, ...5.0947

NEW DRUGS FROM THE SEA, ESPECIALLY ANTIBIOTICS ...Antibiotics, Caribbean Sea, Marine Plants, Pacific Ocean-general, ...6.0123

NUTRIENT STORES IN REPRODUCTION IN SEA INVERTEBRATES ...Crabs, Decapoda -other, Invertebrate Nutrition, Reproductive System, Starfishes, ...5.0949

WATER QUALITY AND FUNGI-NEMATODE-SEAGRASS RELATIONSHIPS ...Elodea, Waterweed, Thalassia, Florida, Habitat Studies, Marine Fungi (non-specific), Nematoda -other, ...5.0878

DEVELOPMENTAL STUDIES OF SELECTED INVERTEBRATES ...Basic Embryology, Developmental Physiology, Hatchability, Maturity & Growth Stages, Size, ...5.0958

UPTAKE OF ORGANIC COMPOUNDS BY MARINE INVERTEBRATES ...Amino Acids, Amino Acids -non-specific, Chemoreceptors, Invertebrate Nutrition, Invertebrates -non-specific, Marine Biology, Metabolism, Pulse-labelling, ...5.0938

MARINE ANIMAL USE IN THE STUDY OF HEALTH PROBLEMS ...Hormones, Hormones - Other, Life History Studies, Metabolism, ...6.0126

NATURAL COMPOUNDS WITH CARBON-PHOSPHORUS BONDS ...Anthozoa, Bond Type, Decomposition-other, Natural Occurring, Phosphorous, ...5.1013

CELL TRANSFORMATIONS, DIVISION, AND MOTION ...Ameboid Movement, Basic Embryology, Cell Cycle, Microtubules, Nucleic Acids, ...5.0234

THE PHYSIOLOGY OF TUNA AND OTHER PELAGIC FISH ...Blood -other, Environmental Physiology, Sharks, Thermonegulation, Tuna, Mackerel, Albacore... , ...5.0272

CIRCULATORY REACTIONS TO ASPHYXIA ...Cardiovascular System, Effects on Cardiovasc. system, Mammals, Veterinary Science, ...5.0553

OSMOREGULATION ...Aquatic Ecology, Osmoregulation, Rays, Skates, Mantas, Sawfish, Sharks, Streams, ...5.0280

CARDIOVASCULAR ADJUSTMENTS IN DIVING MAMMALS ...Adaptation, Cardiovascular System, Effects on Cardiovasc. system, Locomotion -animal, Mammals, ...5.0674

TELEMETRY STUDIES ON MARINE BIRDS ...Albatrosses, Shearwaters... , Bermuda, Mark, Tag Or Capture -other, Pelicans, Cormorants,darters.., Spawning & Nesting Sites, ...5.0531

OPERANT OSMOTIC REGULATION IN A MARINE ANIMAL ...Environment Resistance, Learning and Retention, Octopus, Squid, Cuttlefish... , Osmoregulation, Water Salinity, ...5.0664

THE STRUCTURE AND FUNCTION OF CRUSTACEAN EYES ...Crustacea -non-specific, Invertebrate Anatomy, Light -other, Oceanic - Pelagic, Vertical Distribution, Visual Organs, ...5.0363

ACOUSTICAL COMMUNICATION IN AQUATIC ORGANISMS ...Auditory, Biological Rhythms, Central Nervous System, Orientation, Sound Production, ...5.0318

THE CETACEAN BRAIN - A COMPARATIVE STUDY ...Central Nervous System, Comparative Physiology, Mammals, Structure-cell-tiss, ...5.0641

SENSORY PROCESSES ...Basic Studies, Hawaii, Pathways, ...5.0595

NEURAL MECHANISMS OF LEARNING AND BEHAVIOR ...Behavior, Brain, Gastropods -slugs,conch,snails, Learning and Retention, Mech of Transmission, ...5.0485

LABORATORY OF NEUROBIOLOGY ...Facilities, Nervous System, Puerto Rico, ...12.0044

PHOTOBIOLOGY OF MARINE ANIMALS ...Bioluminescence, Fish -non-specific, Vertebrate Anatomy, Visual, Visual Organs, ...5.0327

PHOTOBIOLOGY OF MARINE ANIMALS ...Photochemistry, Photoreception, Physical State, Visual, Visual Organs, ...5.0313

PROVIDE RESEARCH FACILITIES AND SERVICES ...Facilities, Marine Biology, ...12.0033

ACTIONS OF BIO-TOXINS ON CELL MEMBRANES ...Muscle, Nervous System, Plasma Membrane, Venom, ...6.0128

ENERGY TRANSFER IN LOWER MARINE TROPHIC LEVELS ...Aquatic Ecology, Energy Budgets, Environmental Ecology, Productivity - Food Chain, Vertical Distribution, ...5.1020

EPIZOOTICS IN EXPERIMENTAL MARINE SHELLFISH POPULATIONS ...Epizootic, Freshwater Mussels, Scallops, Mortality Rates, Oysters, Pathology, ...5.0520

MARINE TOXINS OF THE TROPICAL PACIFIC ...Algal Metab.(non-specific &ot), Fish -non-specific, Pacific Ocean-general, Polynesia, Toxicology, Toxins, ...6.0113

Marine Biology (non-specific)

GRANT FOR RESEARCH IN ISOLATION OF MARINE PROTEINS ...Proteins -non-specific, Proteins and Amino Acids, ...**5.0998**

NEW APPROACHES TO BIOFOULING ASSAY ...Bioassays, Corrosion Prevention-other, Fouling, Paint - General, Powder, ...**5.0757**

HYDROSTATIC PRESSURE-TEMPERATURE, AS ENVIRONMENTAL PARAMETERS, ON GROWTH, BIOCHEMISTRY AND PHYSIOLOGY OF MICROORGANISMS ...Growth (non-specific & Ot.), Microorganisms (non-specific), Pressure & Mech Stress, Temperature, ...**5.0821**

MANAGEMENT OF THE ENIWETOK MARINE BIOLOGICAL LABORATORY ...Atolls, Facilities, Lagoons, Reefs, ...**12.0028**

ORGANIC PRODUCTION OF EPIFAUNAL ORGANISMS ...Energy Budgets, Epiphytic Relationships, Organics, Plant Ecosystems(non-specific), Primary Productivity, Reefs, ...**5.1032**

EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC ...Animal Toxins, Pacific Ocean-general, Toxic Substances -non-specific, Toxicological and Allergy, ...**6.0109**

BIOLOGY-MIDDLE EAST WATERS ...Cell Cycle, Middle-east-general, Phenology, Red Sea, Reproductive System, Synchronization, ...**5.0929**

MARINE BIOLOGY RESEARCH AT THE BERMUDA BIOLOGICAL STATION ...Bermuda, Ecology (animal), Marine Biology, Plant Ecology (non-specific), ...**12.0006**

A TRAINING PROGRAM FOR GRADUATE STUDENTS IN MARINE SCIENCES AT THE FRIDAY HARBOR LABORATORIES ...Marine Biology, Training Grants, Fellowships, Washington, ...**11.0042**

YEAR-ROUND PROGRAM OF RESEARCH IN MARINE ECOLOGY ...Animal Taxonomy, Aquatic Ecology, Plant Ecology (non-specific), Plant Taxonomy, Training Grants, Fellowships, ...**5.0899**

GRADUATE SUMMER RESEARCH PROGRAMS IN EXPERIMENTAL EMBRYOLOGY ...Bermuda, Developmental Biology - Animal, Facilities, ...**11.0002**

AIR-SEA INTERACTION AND PLANKTON ECOLOGY ...Circulation-general, Environmental Ecology, Number Or Density, Plankton (non-specific), ...**4.0078**

SUPPORT OF THE R/V EASTWARD ...Caribbean Sea, Continental Shelf, Cooperative-studies, Facilities, Ships and Cruises, Training Grants, Fellowships, ...**12.0039**

COOPERATIVE RESEARCH AND TRAINING PROGRAM IN BIOLOGICAL OCEANOGRAPHY ...Caribbean Sea, Facilities, Meetings, Ships and Cruises, Training Grants, Fellowships, ...**11.0037**

RESEARCH AND TRAINING IN MARINE BIOLOGY ...North Carolina, Training Grants, Fellowships, ...**11.0038**

INTERRELATIONSHIPS OF MARINE ORGANISMS AND SEDIMENTS ...Sediments-general, Training Grants, Fellowships, ...**5.0857**

SURVEY OF MAINE LAW AFFECTING MARINE DEVELOPMENT ...Legal Review, Legal Studies-general, Maine, State Government, Survey Studies, Water Law-general, ...**10.0002**

OPTIMUM ECOLOGICAL DESIGNS FOR ESTUARINE SYSTEMS OF NORTH CAROLINA ...Domestic Wastes-general, Estuaries, North Carolina, Pollution - Effects of , Pollution Effects, Productivity - Food Chain, ...**5.0913**

APPLIED MARINE ENGINEERING PROGRAM AT SCRIPPS INSTITUTION OF OCEANOGRAPHY ...California, Engineering Studies-general, Harbors, Marine Biology, Other-design-and-construction, Scientific-service-support, Teaching and Research, Training Grants, Fellowships, ...**11.0006**

AN APPROACH TO MARINE RESOURCE DEVELOPMENT IN ALASKA ...Alaska, Planning, ...**7.0001**

ORGANIC COMPOUNDS IN THE SEA AND IN MARINE SEDIMENTS ...Organic, Organics, Plankton (non-specific), Removal--organics, Water Analysis, ...**1.0103**

ZONATION OF THE WEDDELL SEA BENTHOS ...Benthic Organisms (non-specif), Environmental Ecology, Temperature, Weddell Sea, ...**5.0868**

OPERATION OF THE R/V HERO AND PALMER STATION SUPPORT LABORATORY ...Antarctica, Facilities, Ships and Cruises, ...**12.0023**

BENTHONIC BIOLOGY ...Benthic Organisms (non-specif), Environmental Ecology, Fouling, Number Or Density, Temporal Distribution, ...**5.0900**

ARCTIC PLANKTON ECOLOGY ...Acoustical, Arctic, Oceanic Fronts, Plankton (non-specific), Population Dynamics, ...**1.0017**

BIOTELEMETRY ...Instrumental Services, Marine Biology, Telemetry, ...**8.0070**

RESEARCH PANELS IN MARINE BIOLOGY ...Committee-support, ...**11.0009**

MARINE LABORATORY ...Louisiana, ...**5.0892**

ULTRASTRUCTURE OF VARIOUS MARINE AND BRACKISH WATER ORGANISMS ...Developmental Biology - Animal, Differentiation Mechanism, Electron Microscopy, Plant Developmental Biology, ...**5.0640**

THE ECOLOGICAL ARCHITECTURES OF THE MARINE BIOSPHERE ...Marine Biology, ...**5.0859**

OXYGEN RESOURCES OF TIDAL WATERS ...Autotrophic, Oxygen, Oxygen Content -water, Pollution Sources-general, Tides, ...**1.0119**

MOBILITY OF OIL-TYPE PRESERVATIVES IN IMMERSED WOOD ...Creosote, Evaluation, Forestry, Liquid - Solid Interactions, Wood Preservatives-non-specif, ...**8.0238**

NATURE OF INTERTIDAL EROSION ON CORAL ATOLLS ...Atolls, Erosion, Fossil Limestone, Intertidal Areas, ...**7.0210**

PHYSIOLOGY AND ECOLOGY OF THE ADRIATIC BENTHOS ...Adriatic Sea, Benthic Organisms (non-specif), Metabolism, Microclimate-general, Productivity - Food Chain, ...**5.0873**

BIOTA OF THE RED SEA AND EASTERN MEDITERRANEAN ...Migration, Red Sea, Survey Studies, ...**5.0691**

BIOLOGICAL OCEANOGRAPHY AND DETERIORATION, POLYMER STUDIES ...Corrosion General, Lubricants and Fluids, Marine Biology, Plankton (non-specific), Wear, Friction, ...**8.0235**

PESTICIDE KINETICS ...Aquatic Or Soil-aquatic Cycles, Degradation, Estuaries, Insecticides -non-specific, Pollutants - Path of , ...**6.0148**

BIOGEOGRAPHY OF BENTHONIC ORGANISMS ...Benthic Organisms (non-specif), Continental Shelf, Range Or Territorial Distr. , Vertical Distribution, ...**5.0876**

HISTOLOGICAL, HISTOCHEMICAL AND HISTOPATHOLOGICAL EFFECTS OF WATER POLLUTANTS ON MARINE ORGANISMS ...Histochemistry - Cytochem, Histology and Cytology, Pollution Sources-general, Toxic Substances -non-specific, ...**5.0923**

ENVIRONMENTAL CONDITIONS AND POPULATION DYNAMICS IN SELECTED UNPOLLUTED ESTUARIAL AND COASTAL AREAS ...Aquatic Ecology, Contamination - Water, Habitat Studies, Pollution - Effects of , Toxic Substances -non-specific, ...**5.0922**

THE ENVIRONMENTAL REQUIREMENTS OF MARINE PLANKTONIC ORGANISMS ...Bulk Culture -other, pH - water, Plankton (non-specific), Water Salinity, Water Temperature -other, ...**5.0921**

ELUCIDATION OF THE METABOLIC PATHWAYS OF MARINE PLANKTONIC ORGANISMS ...Metabolism (intracellular), Organelle-enzyme Assn, Plankton (non-specific), Purification & Isolate, Reaction Rates, ...**5.0828**

USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS ...Bioassays, Chemical Identification, Plankton (non-specific), Pollution - Effects of , ...**6.0183**

RADIOBIOLOGICAL RESEARCH ON MARINE ORGANISMS ...Facilities, Marine Biology, ...**11.0029**

ASPECTS OF RELATIONSHIPS BETWEEN MARINE ECOLOGY AND HUMAN HEALTH ...Environmental Ecology, Mechanism of Transmission, Public Health Ecology, Toxic Substances -non-specific, ...**6.0182**

Marine Plants

THE MARINE ALGAE OF VIRGINIA ...Algae- General, Benthonic-bottom, Chesapeake Bay, Plant Taxonomy, Virginia, ...**5.0698**

STUDIES ON THE PHYSIOLOGY OF MARINE ORGANISMS USING RADIOISOTOPES ...Equipment Purchase Operation, Facilities, Radioisotopes -non-specific, ...**12.0031**

MARINE ALGAE OF THE MANGROVE ROOT COMMUNITY ...Algae- General, Habitat Studies, Mangroves, Puerto Rico, Roots, ...**5.0723**

SUPPORT OF TRAINING PROGRAMS IN INVERTEBRATE ZOOLOGY AND MARINE BOTANY ...Invertebrates -non-specific, Marine Biology, Marine Environments-general, Meetings, Training Grants, Fellowships, ...**11.0028**

DETERMINATION OF CHLOROPHYLL DERIVATIVES ...Catabolism and Degradation, Cell Injury and Autolysis, Fluorometry, Phytoplankton, ...5.0770

RELATIONSHIP OF PHOTOSYNTHESIS TO RESPIRATION OF OCEANIC MICROALGAE ...Light, Mass Spectroscopy, Oxygen, Photosynthesis, Respiration, ...5.0774

ENVIRONMENTAL EFFECTS ON THE METABOLISM OF MARINE ALGAE ...Enzymes, Glycolic Acid, Laminariaceae (non-specif.&ot), Light, Phytoplankton, Responses to Growth, ...5.0702

LOGISTIC SUPPORT, MAINTENANCE AND RENOVATION OF FACILITIES ...Facilities, Maine, Marine Biology, ...12.0029

MOLECULAR MECHANISMS IN BIOLOGICAL CLOCKS ...Control and Regulation, Gonyaulax, ...5.0983

SYSTEMATICS AND ECOLOGY OF SUBTIDAL BENTHIC MARINE ALGAE ...Algae- General, Benthic Flora, Benthonic-bottom, Habitat Studies, Plant Taxonomy, Range Or Territorial Distr. , ...5.0701

PHYSIOLOGY AND ECOLOGY OF MARINE DIATOMS ...Algae- Diatoms, Algal Culture, Habitat Studies, Nutrition Studies, Physiological Ecology, Plant Taxonomy, ...5.0735

NUTRIENT LIMITATION AND SOURCES OF NITROGEN FOR MARINE PRIMARY PRODUCTIO ...Mathematical Biophysic, Nitrogen Fixation, Other Models, Phytoplankton, Primary Productivity, ...5.0845

ALGAL SUBSTANCES IN THE MARINE FOOD WEB ...Food Chains, Food Webs, Humic Acid, Phaeophyta (non-specific & Ot), Phenols, Secretions and Products, ...5.0725

RESTORATION, PROPAGATION, AND MANAGEMENT OF MARINE ALGAE ...Applied Ecology, Growth and Differentiation, Habitat Studies, Laminariaceae (non-specif.&ot), Pacific Ocean-east, ...5.0680

ORGANIC INFLUENCES ON CALCIUM CARBONATE CEMENTATION ...Algae- General, Algal Culture, Biology, Cement Origin, Secretions and Products, ...5.0729

LIGHT REQUIREMENTS FOR MARINE ALGAE ...Algae-General, Algal Culture, Autotrophic, Light, Pigments, ...5.0703

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OREGON-CALIFORNIA BLACK SANDS ...Beaches, California, Heavy Mineral Analysis, Heavy Minerals, Mineralogy, Ocean Mining, ...7.0015

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GEOLOGICAL, GEOPHYSICAL, OCEANOGRAPHIC, AND ECOLOGICAL DATA ON WORLDWIDE BASIS, ON AREAS OF HEAVY METALS POTENTIAL ...California, Continental Shelf, Drilling and Coring, Oregon, Placer, ...7.0005

Resource Inventories

MARINE MINERAL RESOURCES OF THE NORTH CAROLINA CONTINENTAL MARGIN ...Continental Shelf, North Carolina, ...7.0026

WORLD WIDE MARINE MINERAL RESOURCES ...Continental Shelf, Continental Slope, Economics, Mapping, Potential of Deposit, ...4.0056

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Apatite-general

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Kaolinite

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Silicate-general

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Quartz

PRECISION QUARTZ CAPACITANCE PRESSURE TRANSDUCERS ...Capacitance, Pressure, Technique Development, Transducers, ...8.0121

Mississippi

MISSISSIPPI DELTA ...Deltas, Distribution, Heavy Minerals, Ocean Mining, Potential of Deposit, Sedimentary History, ...7.0014

Mississippi River

A STUDY OF COLIFORM BACTERIA AND ESCHERICHIA COLI ON POLLUTED AND UNPOLLUTED OYSTER BOTTOMS OF MISSISSIPPI ...Coliforms (non-specific), Identification, Sampling, Sewage, Vertical Distribution, ...5.0465

ENVIRONMENT OF DEPOSITION OF ARGILLACEOUS SEDIMENTS ...Adsorption Capacity, Boron, Chemistry, Clays, Deltas, ...7.0240

Mixing

DEVELOPMENT OF PHYSICAL-NUMERICAL MODELS FOR STUDIES OF THE ATMOSPHERE-OCEAN PLANETARY BOUNDARY LAYER ...Advection, Simulation Theory, Thermal, Turbulence, Wind-water Interaction, ...3.0010

COLUMBIA RIVER EFFECTS IN THE NORTHEAST PACIFIC ...Bed Load, Benthonic-bottom, Columbia River, Ocean Waves - Currents, Oceanic Fronts, ...2.0065

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OCEAN-ATMOSPHERE STUDIES WITH STABLE ISOTOPES AND DISSOLVED GASES ...Air-sea Boundary-general, Equilibrium - Chemical, Gases, Oceanic Fronts, Particle-gas Transfer, Tracers, ...3.0005

TRITIUM AS A TRACER FOR MIXING PROCESSES ...Currents-ocean, Radioactivity-general, Salinity, Tracers, Tritium, ...2.0053

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OPTICAL OCEANOGRAPHY IN FLORIDA BAY, FLORIDA STRAITS AND BAHAMA BANK ...Distribution, Optical, Optical Devices, Sedimentation, Wind-water Interaction, ...1.0163

EXPERIMENTAL STUDY OF THE INTERRELATIONS BETWEEN WIND-WAVE PROPERTIES ...Hydrodynamics, Pressure, Turbulence - Sea Water, Waves, Wind-water Interaction, ...2.0123

RESEARCH IN OCEANIC PHYSICS ...Atlantic Ocean-south, Convection, Oceanic Fronts, Thermodynamics, Wind-water Interaction, ...2.0059

STUDY OF STABILITY AND SHEAR IN THE TOP 500 METERS OF THE OCEAN ...California Current, Density, Water Motion, Water Motion Recorders, ...1.0171

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PHYSICAL OCEANOGRPAHY IN OREGON SHELF AND SLOPE WATERS ...Continental Shelf, Continental Slope, Hydrodynamics, Oregon, Thermodynamics, ...2.0076

THE INSTITUTE FOR THE DEVELOPMENT OF RIVERINE AND ESTUARINE SYSTEMS (IDRES) ...Delaware River, Estuaries, Waste Disposal-general, ...12.0043

NATURAL RADIOCARBON MEASUREMENTS ...Carbon-14, Facilities, Oceanic Fronts, Pacific Ocean-general, Radioactivity, ...1.0084

CHEMICAL PROPERTIES OF SEA WATER AND THEIR USE IN STUDIES OF WATER MASSES AND MIXING ...Chemical Reactions, Gases, Oceanic Fronts, Pacific Ocean-east, Water Analysis, ...1.0126

CHARACTERISTICS, CAUSES, AND PREDICTION OF UPWELLING WATER MASSESS OFF OREGON ...Forecasting-prediction, Oceanic Fronts, Oregon, Pacific Ocean-east, Water Motion Recorders, ...2.0062

ORGANIC MATTER ...Atlantic Ocean-general, Oceanic Fronts, Organics, Oxygen, Sampling, Ships and Cruises, ...1.0111

MIXING PROCESSES INFLUENCING THE OCEANIC ENVIRONMENT ...Currents-ocean, Density, Model Studies, Moorings, Underwater-construction, ...2.0054

CHEMICAL STUDIES OF THE OCEANIC ENVIRONMENT ...Chemical Reactions, Marine Biology, Oceanic Fronts, Pacific Ocean-east, Trace Elements, Water Analysis-general, ...1.0136

FINE STRUCTURE FEATURES OF TEMPERATURE AND SALINITY AT WATER MASS BOUNDARIES IN PACIFIC

...Circulation-general, Oceanic Fronts, Pacific Ocean-north, Salinity, Temperature, ...**2.0046**

EASTERN BOUNDARY CURRENTS ...Ocean Currents-other, Pressure-density, Wind-general, Wind-water Interaction, ...**2.0026**

REMOTE SENSING ...Currents-ocean, Gases, Microwave Radiation, Oil, Salinity, Temperature, ...**4.0171**

MARINE RADIOLOGICAL INSTRUMENTATION ...Acoustical, Chemical Analysis (water), Circulation-general, Laboratory Analysis, Radioactivity-general, Sampling, ...**8.0062**

EDDY DIFFUSION AND BACTERIAL REDUCTION IN WASTE FIELDS ...Bacterial Pollutant Sources, Diffusion, Dispersion -water, Dyes, Pollutants - Path of , Sewers, ...**6.0137**

BIG EDDIES AND MIXING PROCESSES IN THE GREAT LAKES ...Circulation -water, Dispersion -water, Effluents-waste Water, Great Lakes-general, Water Motion, ...**2.0052**

OCEANOGRAPHIC FACTORS IN THE FUNCTIONAL DESIGN OF WASTE DISPOSAL SYSTEMS ...Jet Flow-other, Nuclear Power, Outlet, Process Design, Sewers, ...**8.0325**

SALINITY INTRUSION AND RELATED PHENOMENA ...General Deposition, Ocean Currents-other, Open Channel Flow, Saline Water Intrusion, Sediment Transport-general, ...**2.0061**

WESTERN ARCTIC OCEANOGRAPHIC INVESTIGATIONS ...Arctic, Arctic Ocean, Basins, Circulation-general, ...**2.0014**

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RATE OF ABSORPTION OF ENDRIN BY BLUEGILL SUNFISH ...Bioassay, Bluegills, Bream, DDT , Endrin, Metabolism, ...**5.0263**

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...Dursban, Estuaries, Model Studies, Pollution - Effects of , Sevin, ...**5.0919**

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HONEYWELL ACOUSTIC RESEARCH PROGRAM ...Acoustical, Data Acquisition, Data Analysis - General, Interfaces, Reverberation, Sonar, ...**1.0071**

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DEEP SUBMERGENCE VEHICLES - DYNAMIC ANALYSES ...Data Acquisition, Experiments and Tests, Mathematical Analysis, Submersibles, Technique Development, Underwater-laboratory, ...**8.0264**

CALORIC - AN INVESTIGATION OF HEAT RELEASE PATTERNS ASSOCIATED WITH PRESENT AND PLANNED LAKESHORE ELECTRICAL POWER PLANTS ...Electric Power Plants, Lake Erie, Nuclear Power, Pollution - Effects of , Temperature, Thermal Pollution, ...**1.0186**

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SIMULATION MODELS OF SHALLOW-WATER AND COASTAL ENVIRONMENTS ...Computer Applications, Gulf of Mexico, Hydrology-general, Sedimentation, Shoreline - Coastline, ...**4.0066**

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OCEAN WAVES ...Profiles, Temperature, Waves, Waves-internal, Wind-water Interaction, ...**3.0004**

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MARINE HYDRODYNAMICS ...Antarctic Ocean, Circulation-general, Laboratory Analysis, Waves, Waves-internal, ...**8.0196**

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TRANSPORT PROCESSES ACROSS AN AIR-WATER INTERFACE ...Air-sea Boundary-general, Statistics-general, Wind-water Interaction, ...**3.0003**

TIME FLUCTUATIONS IN OCEAN CURRENTS ...Currents-ocean, Geomorphology-topography, Testing of Models, Waves, ...**2.0039**

THEORY OF LARGE-SCALE ATMOSPHERIC AND OCEANIC PROCESSES ...Circulation-general, Currents-ocean, Tropic, Weather Forecasting, Wind-water Interaction, ...**2.0070**

ESTUARINE SEDIMENTARY MODELS ...Circulation-general, Distribution, Estuaries, Grain Size, Textures-structures, ...**4.0079**

STUDIES OF OXYGEN-FREE, SULFIDE-BEARING MARINE ENVIRONMENTS ...Chemistry, Organics, ...**1.0135**

(U) OCEAN CIRCULATION MODELS ...Circulation-general, Currents-ocean, Shear, Waves, Wind-water Interaction, ...**2.0024**

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FLUID DYNAMICS CENTER ...Cloud Formation and Evolution, Cloud Physics, Coastlines-shorelines, Satellites, Tropical Cyclones, ...**8.0178**

ISLAND-CURRENT INTERACTIONS ...Acoustical, Currents-ocean, Data Analysis - General, Geomorphology, Islands, ...**2.0116**

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MIXING PROCESSES INFLUENCING THE OCEANIC ENVIRONMENT ...Currents-ocean, Density, Mixing, Moorings, Underwater-construction, ...**2.0054**

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MEASUREMENT AND INTERPRETATION OF MOTIONALLY-INDUCED ELECTRIC FIELDS IN THE SEA ...Currents-ocean, Electrical, Forecasting-prediction, Marine Environments-general, Moorings, Water Motion Recorders, ...**1.0139**

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NUMERICAL OCEANOGRAPHIC MODEL DEVELOPMENT FOR ENVIRONMENTAL PREDICTION ...Forecasting-prediction, Marine Environments-general, Meteorological Studies, Oceanic Fronts, Weather Forecasting, ...**4.0077**

SEA ICE MOVEMENT DYNAMICS ...Charts, Forecasting-prediction, Mapping, Polar, Sea Ice, ...**3.0087**

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RESEARCH IN OCEAN PROPERTIES ...Acoustical, Geomorphology-topography, Geophysical Equipment, Marine Biology, Seismic Studies, Subbottom, ...**7.0132**

RESEARCH IN OCEANOGRAPHIC SPECIAL CHARTS ...Acoustical, General Sediment Type, Geomorphology-topography, Seismic Reflection, Seismic Studies, Subbottom, ...**1.0062**

VERTICAL OCEAN CIRCULATION ...Circulation-general, Convection, Oceanic Fronts, Subsurface Environments, ...**2.0036**

FIORD OCEANOGRAPHY ...Alaska, Estuaries, Fjords, Hydrodynamics, Simulation Theory, ...**4.0040**

NEARSHORE WAVE THEORY ...Development, Sediment Transport-general, Shoreline - Coastline, Waves, ...**2.0119**

BOTTOM CURRENTS AND DEEP SEA TIDES ...Abyssal, Acoustical, Benthonic-bottom, Currents-other, Finite Differences, Tides, ...2.0004

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OCEAN CIRCULATION ...California Current, Circulation-general, Forecasting-prediction, Hydrodynamics, Submarine Canyons, ...2.0002

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AN ANALYTICAL AND EXPERIMENTAL STUDY OF BED FORMS UNDER WATER WAVES ...Channel Roughness, Friction, Geomorphology-topography, Water Tunnels Tables, Wave Action, Waves, ...2.0110

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EUTROPHICATION OF TIDAL WATERS ...Eutrophication, Growth and Differentiation, Nutrients, Photosynthesis, Tidewater Areas, ...5.0909

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GEOLOGICAL AND HYDROGRAPHIC STUDY OF THE WILMINGTON SUBMARINE CANYON AND ADJACENT AREAS ...Bottom Sampling Device, Geomorphology-topography, Photography, Submarine Canyons, Textures-structures, ...7.0211

CIVIL ENGINEERING STRUCTURES IN THE OCEANS ...Coastal Engineering-other, Engineering Studies-other, Foundations-general, Soil Dynamics, Waves, ...8.0340

WAVE FORCES ON BREAKWATERS ...Breakwaters, Hydrodynamics, Shoreline Structures, Wave Action, Waves, ...8.0044

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AN OPTIMUM LOADING SEQUENCE FOR CONTAINERSHIPS ...Computer Applications, Engineering Studies-other, Freight, Loading/unloading, Packing, ...8.0033

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POLLUTION STUDY OF THE VENICE DISTRICT CANAL ...California, Canals, Synthetic Hydrology, Water Quality-general, ...6.0141

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OCEAN DYNAMICS SEA AIR INTERACTION MODELS-MEDITERRANEAN ...Acoustical, Hydrodynamics, Mediterranean Sea-general, Surface Environments, Wind-water Interaction, ...3.0002

OCEAN DYNAMICS IN THE STRAITS OF GIBRALTAR AND ADJACENT AREAS ...Acoustical, Anti-submarine-warfare, Computer Applications, Hydrodynamics, Strait of Gibraltar, Submerged Ships, ...1.0141

OCEAN DYNAMICS - OCEANOGRAPHIC ANALYSES AND FORECASTING MODELS ...Acoustical, Air-sea Boundary-general, Hydrodynamics, Surface Environments, Temperature, ...1.0004

OCEANOGRAPHIC RESEARCH-INVESTIGATIONS IN SHALLOW WATER ...Acoustical, Environmental Effects-geologic, Salinity, Thermal, Water Motion, ...1.0009

INTERNAL WAVE STUDIES ...Acoustical, Refraction, Scattering, Surface Environments, Waves-internal, ...1.0021

ARCTIC UNDERSEAS RESEARCH, PHYSICAL AND CHEMICAL PROPERTIES OF SEA ICE ...Arctic Ocean, Environmental Effects-geologic, Ice Properties-general, Sea Ice, ...3.0070

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ADVANCED TECHNOLOGY AND BOTTOM PREDICTIONS ...Acoustical, Benthonic-bottom, Data Acquisition, Data Analysis - General, Forecasting-prediction, Seismic Studies, ...1.0045

OCEAN CURRENTS AND CIRCULATION ...Circulation-general, Currents-ocean, Data Acquisition, Energy, Temperature, ...2.0015

SHALLOW WATER ACOUSTIC STUDIES ...Acoustical, ...1.0042

AMBIENT NOISE RESEARCH STUDIES ...Acoustical, Depth, Noise, Spectra, ...1.0023

ENVIRONMENTAL SUPPORT OF SONAR DESIGN ...Acoustical, Liquids, Ships and Cruises, Transmission, Water Properties-general, ...1.0015

GENERAL COASTAL INLET STUDIES ...Coastal Engineering-other, Coastlines-shorelines, Discharge, Synthetic Hydrology, Tides, Water Motion, ...7.0125

GREAT LAKES RESEARCH - COASTAL AREA SEDIMENTATION ...Beach, Development, Energy, General Transport Effects, Great Lakes-general, Sedimentation, ...7.0124

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NUMERICAL SIMULATION OF HYDRODYNAMIC PHENOMENA BY DIGITAL COMPUTER ...Groundwater, Open Channel Flow, Porous Media - Flow Through, Subsurface Flow, Waves, ...4.0083

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SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES ...Behavior, Environmental Physiology, Fish -non-specific, Migration, Sensory Organs, ...5.0338

ACOUSTICO-LATERALS FUNCTION IN FISH ORIENTATION AND COMMUNICATION ...Auditory, Behavior, Fish -non-specific, Sensory Organs, Signal Detection, ...5.0289

DISTANT GOAL ORIENTATION ...Biological Rhythms, Birds - non-specific, Locomotion -animal, Magnetic Impulses, Mark, Tag Or Capture -other, ...4.0109

ORIENTATION CUES AND PATTERNS OF LONG-DISTANCE TRAVEL OF MARINE TURTLES ...Biological Rhythms, Environmental Physiology, Migration, Turtles, Terrapins, Tortoises, ...4.0102

ACOUSTICAL COMMUNICATION IN AQUATIC ORGANISMS ...Auditory, Biological Rhythms, Central Nervous System, Sound Production, ...5.0318

Parental Care

EXPERIMENTAL STUDIES OF BEHAVIOR IN A CICHLID FISH ...Behavior, Sex, Size, Tilapia, Cichlids, ...5.0232

Sex

EXPERIMENTAL STUDIES OF BEHAVIOR IN A CICHLID FISH ...Behavior, Parental Care, Size, Tilapia, Cichlids, ...5.0232

Social Behavior

MOTIVATIONAL ANALYSIS OF COURTSHIP BEHAVIOR ...Aggression, Behavior, Tilapia, Cichlids, ...5.0231

THE EVOLUTION AND CAUSATION OF SOCIAL BEHAVIOR IN ANABANTOID FISHES ...Behavior, Ethological, Fish - other, Reproduction Studies (general), ...5.0300

SCHOOLING BEHAVIOR IN FISHES ...Behavior, Fish -non-specific, Sensory Organs, Visual Organs, ...5.0125

COMPARATIVE ETHOLOGY OF FISHES OF THE GENUS MACROPODUS ...Aggression, Behavior, Fish -other, ...5.0266

Mountains-alpine

ALPINE LIMNOLOGY PROJECT ...Core Analysis, Dust - Particulate Matter, Extrusives, Hawaii, Lakes, Volcanoes, ...7.0236

Mucus

STUDY OF FISH MUCUS BIOCHEMISTRY ...Fish -non-specific, Locomotion -animal, ...8.0172

Museum

PORCELLANID CRABS OF AUSTRALIA ...Australia, Collections, Crabs, Nomenclature, Classification, ...5.0354

SHORE FISHES OF ANNOBON AND FERNANDO POO ...Art Work-illustrations-etc, Atlantic Ocean-general, Collections, Fish -non-specific, ...5.0067

BIOLOGY OF THE ANTARCTIC BRACHIOPOD FAUNA ...Animal Taxonomy, Range Or Territorial Distr. , ...5.0454

SYSTEMATIC REVISION PLATYCEPHALIDAE (PISCES) ...Classical, Fish -other, Indian Ocean-general, Nomenclature, Classification, ...5.0050

Naval Architecture

Control-systems

DEPTH CONTROLLED STREAMER DEVELOPMENT ...Depth, Equipment, Hydrographic, Sonar, ...8.0139

RESEARCH SUBMARINE BEAVER MK IV ...Diving and Scuba, Scientific-service-support, Submersibles, Technique Development, Underwater-laboratory, ...8.0265

FUNCTIONAL AND ECONOMIC ANALYSIS OF SHIP MANEUVERING SYSTEMS ...Merchant-ships, ...8.0324

SHIP MANEUVERING AND CONTROL ...Merchant-ships, Moorings, Safety, Tankers, ...8.0313

AUTOMATIC BOILER CONTROLS ...Boilers, Marine Propulsion, Steam, ...8.0164

OPERATION OF BARGE TRAINS IN A SEAWAY ...Barges-towboats, Operational Aspect, ...8.0034

ADVANCED NUCLEAR CARGO SHIP ...Merchant-ships, Nuclear, Other-design-and-construction, Safety, ...8.0274

VLF/OMEGA NAVIGATION ...Communication & Navigation, Navigation, Navigation Communication, Satellites, ...4.0106

DEEP SEA SUBMERSIBLES ...Hull, Life-support-system, Marine Propulsion, Moorings, Submersibles, ...8.0292

FLUIDIC CONTROL SYSTEM COMPENSATOR ...Control Systems, Controls, ...8.0193

A DUAL MODE ROLE STABILIZATION SYSTEM ...Applications, Development of Models, Models, Ship Resistance Stability, Submersibles, ...8.0302

AN EXPERIMENTAL INVESTIGATION OF PARTIALLY SHROUDED POPELLERS ...Drag, Lift, Marine Propulsion, Rotors-propellers, ...8.0305

Diving-system

SHALLOW WATER OCEANOGRAPHY (SEALAB III) ...Diving and Scuba, Environmental Effects-geologic, Instrumentation-general, Underwater-laboratory, ...1.0146

DEEP OCEAN SYSTEMS ...Diving and Scuba, Submersibles, Underwater-construction, ...8.0339

SWIMMER HIGH DEFINITION SONAR ...Diving and Scuba, Engineering Studiesoother, Maintenance-system, Sonar, Underwater-construction, ...8.0019

ONE ATMOSPHERE DIVERS SUIT ...Diving and Scuba, Life-support-system, Technique Development, ...8.0020

ADVANCES HEAT SOURCES AND THERMAL INSULATION MATERIALS FOR SWIMMER HEATING ...Diving and Scuba, Heat Transfer, Heating, Thermal, Thermal Insulators, ...8.0021

DIVER NAVIGATION DEVICE ...Bathymetry, Diving and Scuba, Navigation, Technique Development, ...6.0131

Equipment

DEPTH CONTROLLED STREAMER DEVELOPMENT ...Control-systems, Depth, Hydrographic, Sonar, ...8.0139

MODIFY 19 OCEAN BOTTOM SEISMOGRAPHS AND CONDUCT TESTS WITH THE DEVICE ...Benthonic-bottom, Geophysical Equipment, Seismographs, ...8.0110

SONIC UNDERWATER NAVIGATION FOR SHIPS ...Instrumentation-other, Navigation, Ranging, Sonar, Sound Gear, ...4.0100

CONSTRUCTION SYSTEMS ...Benthonic-bottom, Engineering Studies-other, Submerged Ships, Underwater-construction, ...8.0120

DEVELOPMENT, TESTING AND EVALUATION OF MODIFICATIONS REQUIRED TO ADAPT DRILLING SAMPLING SYSTEMS TO THE PLATFORM ...Bottom Sampling Device, Coring and Dredging, Drilling and Coring, Platforms, Technique Development, ...8.0256

OPERATIONAL EVALUATION OF NSRT SYSTEM ...Special Mission Ships, Surface Environments, Temperature, ...8.0059

SURVIVAL CRAFT DRIFT AND LEEWAY ...Air Motion Instruments, Buoys, Currents-ocean, Ocean-lakes, Operational Aspect, Tables, Compilations, Catalogs, ...6.0129

Experiments and Tests

DEEP SUBMERGENCE VEHICLES - DYNAMIC ANALYSES ...Data Acquisition, Mathematical Analysis, Model Studies, Submersibles, Technique Development, Underwater-laboratory, ...8.0264

MAN IN THE SEA - VISUAL ACUITY RESEARCH ...Acuity, Divers, Diving and Scuba, Optical, Submersibles, ...6.0089

THE EVALUATION AND USE OF SUBMERGED RESEARCH VESSELS IN STUDYING CONTINENTAL SHELF ENVIRONMENTS ...Continental Shelf, Operational Aspect, Submerged Ships, Submersibles, ...4.0128

SHIP STRUCTURE LABORATORY TESTING AND ANALYSES ...Bulkheads, Hull, Hydrodynamic Structures, Models, ...8.0261

OCEANOGRAPHIC ENGINEERING ...Bathythermographs, Engineering Studies-other, Other-design-and-construction, Platforms, Special Mission Ships, ...8.0269

BUOY ENGINEERING ...Buoys, Moorings, Water Motion, ...8.0309

DEEP OCEAN ENGINEERING TECHNOLOGY ...Abyssal, Benthonic-bottom, Buoys, Facilities, Platforms, Scientific-service-support, ...8.0270

AN INVESTIGATION OF THE PERFORMANCE OF A COLUMN STABILIZED PLATFORM ...Engineering Studies-other, Models, Platforms, Ship Resistance Stability, ...8.0296

Facilities

SHIPBUILDING COST ESTIMATING METHODOLOGY ...Other-design-and-construction, ...8.0271

DEEP OCEAN ENGINEERING TECHNOLOGY ...Abyssal, Benthonic-bottom, Buoys, Experiments and Tests, Platforms, Scientific-service-support, ...8.0270

EXPERIMENTAL INVESTIGATION OF VENTILATED CAVITIES ...Pulsating, Rotors-propellers, Ventilated Cavities, Ventilated Flow, ...8.0185

SUPPORTING SYSTEMS ...Underwater-laboratory, ...8.0338

Hydrofoils Crafts

VARIABLE PRESSURE WATER TUNNEL RESEARCH ...Cavity Flow, Facilities, Marine Propulsion, Shock-vibration, Sound Field, Water Tunnels Tables, ...8.0183

HIGH SPEED SHIP PROPULSION ...Marine Propulsion, ...8.0315

40,000 HORSEPOWER PLANETARY REDUCTION GEAR SYSTEM ...Gearing and Power Train, Marine Propulsion, Turbine-other, ...8.0314

INVESTIGATION OF THE NON-LINEAR CHARACTERISTICS OF FLUID-SUSPENDED VEHICLES ...Dimensionless-parameters-other, Non Linear, Non-linear, Simulation Theory, Stability, ...8.0184

PRELIMINARY CALCULATION OF THE LIFT AND DRAG AND ANGLE OF ATTACK FOR SUBMERGED HYDROFOILS ...Computer Applications, Drag, Lift, ...8.0278

MODEL FOR THE PRELIMINARY DESIGN OF SURFACE EFFECT SHIPS ...Computer Applications, Drag, Marine Propulsion, Other Models, Ships and Cruises, Waves, ...8.0279

Life-support-system

ENVIRONMENTAL PHYSIOLOGY ...Diving and Scuba, Medical Studies, Pressure, Submersibles, Underwater-laboratory, ...6.0093

DEEP SEA SUBMERSIBLES ...Control-systems, Hull, Marine Propulsion, Moorings, Submersibles, ...8.0292

SUBMARINE MEDICINE ...Naval Personnel, Occupational Hazards, Ordnance, Safety, ...8.0018

ONE ATMOSPHERE DIVERS SUIT ...Diving and Scuba, Diving-system, Technique Development, ...8.0020

ADVANCED DEEP OCEAN TECHNOLOGY ...Engineering Studies-general, Marine Propulsion, Submersibles, ...8.0282

Marine Propulsion

ANTI-FOULING MEANS FOR MARINE PROPELLERS ...Corrosion Prevention-other, Fouling, Materials Used Undersea, ...8.0240

DEEP SUBMERGENCE SYSTEMS ...Buoyant, Flotational, Geomorphology-topography, Navigation Communication, Physical Properties, Submersibles, Welding - Other, ...8.0051

AUTOMATIC BOILER CONTROLS ...Boilers, Control-systems, Steam, ...8.0164

SELF-REGULATING STEAM GENERATOR ...Controls, Generators, Steam, ...8.0125

PROPULSION EFFICIENCY 'U' VERSUS 'V' STERNS ...Shock-vibration, Stern, ...8.0289

PRESISTANCE AND PROPULSION HUL CONFIGURATION ...Bow, Merchant-ships, Stern, ...8.0310

COLLATION OF POWER PLANT STUDIES ...Diesel, Merchant-ships, Naval Architecture-general, ...8.0161

VARIABLE PRESSURE WATER TUNNEL RESEARCH ...Cavity Flow, Facilities, Hydrofoils Crafts, Shock-vibration, Sound Field, Water Tunnels Tables, ...8.0183

HIGH SPEED SHIP PROPULSION ...Hydrofoils Crafts, ...8.0315

40,000 HORSEPOWER PLANETARY REDUCTION GEAR SYSTEM ...Gearing and Power Train, Hydrofoils Crafts, Turbine-other, ...8.0314

DEEP SEA SUBMERSIBLES ...Control-systems, Hull, Life-support-system, Moorings, Submersibles, ...8.0292

COMPUTATION OF PERIODIC PROPELLER FORCES IN NON-UNIFORM FLOWS USING A LIFTING SURFACE MODEL ...Dimension-three, Models, Non-steady Flow, Rotors-propellers, Turbulent, ...8.0180

A DESIGN PROGRAM FOR SUPERCONDUCTING ELECTRICAL MACHINES ...Electrical, Electromechanical Design, Instrumental Services, Superconductive Device, ...8.0132

THE INVERSE PROBLEM IN PROPELLER DESIGN ...Computer Applications, Rotors-propellers, ...8.0299

CONTROL OF SUPERCONDUCTING MACHINES FOR SHIP PROPULSION ...Engineering Studies-general, Mathematical Analysis, Model Studies, Operational Aspect, ...8.0301

AN EXPERIMENTAL INVESTIGATION OF PARTIALLY SHROUDED POPELLERS ...Control-systems, Drag, Lift, Rotors-propellers, ...8.0305

HYDROGEN PROPERTIES ...Density, Dielectric Properties, Fuel Cell-other, Hydrogen, Refraction, ...8.0157

MODEL FOR THE PRELIMINARY DESIGN OF SURFACE EFFECT SHIPS ...Computer Applications, Drag, Hydrofoils Crafts, Other Models, Ships and Cruises, Waves, ...8.0279

UNDERSEA PROPULSION AND POWER SOURCES ...Batteries, Combustion-other, Generators, ...8.0158

PROPULSION FOR SWIMMER VEHICLES ...Closed-cycle, Diving and Scuba, Submersibles, ...8.0159

ADVANCED DEEP OCEAN TECHNOLOGY ...Engineering Studies-general, Life-support-system, Submersibles, ...8.0282

Merchant-ships

HULL DESIGN - MODULAR DECKHOUSE ...Bridge, Prefabricated, ...8.0318

SEAKEEPING QUALITIES - MOTIONS AND POWERING PREDICTIONS ...Safety, Ship Resistance Stability, Waves, ...**8.0306**

FUNCTIONAL AND ECONOMIC ANALYSIS OF SHIP MANEUVERING SYSTEMS ...Control-systems, ...**8.0324**

SHIP MANEUVERING AND CONTROL ...Control-systems, Moorings, Safety, Tankers, ...**8.0313**

CONTRAROTATING PROPELLER IN JUMBOIZED MARINER ...Models, Modification-conversion, Rotors-propellers, ...**8.0290**

PRESISTANCE AND PROPULSION HUL CONFIGURATION ...Bow, Marine Propulsion, Stern, ...**8.0310**

TRANSITIONAL CONTAINERSHIP CONCEPT ...Freight, Modification-conversion, Other-design-and-construction, ...**8.0317**

COMPETITVE MERCHANT SHIP (BULK) DEVELOPMENTAL PLAN ...Freight, Water Vessel, ...**4.0072**

COMPETITIVE MERCHAND SHIP (BULK) TECHNICAL INNOVATIONS ...Freight, Other-design-and-construction, Water Vessel, ...**4.0064**

EXPERIMENTAL COMMERCIAL OPERATION OF SAVANNAH ...Nuclear, Other-design-and-construction, Safety, ...**12.0035**

ADVANCED NUCLEAR CARGO SHIP ...Control-systems, Nuclear, Other-design-and-construction, Safety, ...**8.0274**

ROLL DISTRIBUTION OF A NUCLEAR CARGO SHIP WITH AND WITHOUT FLUME STABILIZATION ...Nuclear, Other-design-and-construction, Ship Motion & Dynamics, Ship Resistance Stability, ...**8.0319**

MERCHANT SHIP REACTOR PRELIMINARY SAFETY ANALYSIS ...Nuclear, Safety, ...**8.0167**

ECONOMICS OF NUCLAER FUEL ...Costs, Fuel, Nuclear, ...**4.0178**

COMPETITIVE MERCHANT SHIP PROJECT (BULK) DRY BULK COMMODITY FORECASTS ...Consumption, Freight, Transportation Systems, ...**8.0029**

COLLATION OF POWER PLANT STUDIES ...Diesel, Marine Propulsion, Naval Architecture-general, ...**8.0161**

THE FEASIBILITY OF REDUCED CARGO GEAR INSTALLATION ONBOARD BREAK-BULK CARGO SHIPS ...Hull, Loading/unloading, Material Handling Devices, ...**8.0035**

DIGEST OF THE ADVANCED NUCLEAR CARGO SHIP STUDY ...Freight, Nuclear, Other-design-and-construction, ...**8.0275**

A STUDY OF A TRANSITIONAL CONTAINERSHIP CONCEPT ...Freight, Naval Architecture-general, Other-design-and-construction, ...**8.0277**

ADVANCED MARINE TRANSPORTATION SYSTEM/ANALYSIS MODEL ...Algorithms, Consumption, Cost Analysis, Input - Output Analysis, Models, Systems Analysis, ...**4.0068**

Models

SHIP STRUCTURE LABORATORY TESTING AND ANALYSES ...Bulkheads, Experiments and Tests, Hull, Hydrodynamic Structures, ...**8.0261**

CONTRAROTATING PROPELLER IN JUMBOIZED MARINER ...Merchant-ships, Modification-conversion, Rotors-propellers, ...**8.0290**

CATAMARAN CONTAINERSHIP FEASIBILITY ...Barges-towboats, Computer Applications, Freight, Storage, ...**8.0273**

AN OPTICAL METHOD OF MEASURING THE FORM OF THE FREE SURFACE OF A FLUID ...Fluid Dynamics, Free Surface Waves, Optical, Optical Systems, Watersheds, Waves, ...**2.0124**

STEP RESPONSE METHOD FOR DETERMINING HORIZONTAL COEFFICENT FOR DEEP SUBMERSIBLES ...Submerged Ships, Submersibles, ...**8.0293**

COMPUTATION OF PERIODIC PROPELLER FORCES IN NON-UNIFORM FLOWS USING A LIFTING SURFACE MODEL ...Dimension-three, Marine Propulsion, Non-steady Flow, Rotors-propellers, Turbulent, ...**8.0180**

AN INVESTIGATION OF THE PERFORMANCE OF A COLUMN STABILIZED PLATFORM ...Engineering Studies-other, Experiments and Tests, Platforms, Ship Resistance Stability, ...**8.0296**

A DUAL MODE ROLE STABILIZATION SYSTEM ...Applications, Control-systems, Development of Models, Ship Resistance Stability, Submersibles, ...**8.0302**

MARINE TRANSPORTATION ANALYSIS MODEL ...Cost Analysis, Input - Output Analysis, Ports & Harbors, Water Vessel, ...**8.0031**

ADVANCED MARINE TRANSPORTATION SYSTEM/ANALYSIS MODEL ...Algorithms, Consumption, Cost Analysis, Input - Output Analysis, Merchant-ships, Systems Analysis, ...**4.0068**

Moorings

SHIP MANEUVERING AND CONTROL ...Control-systems, Merchant-ships, Safety, Tankers, ...**8.0313**

MOORING IMPROVEMENT SYSTEM ...Safety, ...**8.0316**

DYNAMICS OF MOORED BUOY SYSTEMS USED IN OCEANOGRAPHY R&D AND SURVEILLANCE ...Buoys, Currents-ocean, Laboratory Analysis, Model Studies, Waves, ...**8.0321**

OCEAN ENGINEERING RESEARCH ...Alloys, Engineering Studies-general, Materials Used Undersea, Water, Water Properties-general, ...**8.0050**

BUOY ENGINEERING ...Buoys, Experiments and Tests, Water Motion, ...**8.0309**

TELEMETERING BUOY SYSTEM FOR OCEANOGRAPHIC RESEARCH AND ENIVRONMENTAL PREDICTION ...Buoys, Data Acquisition Systems, Meteorological Studies, Navigation Communication, Oceanography-general, Technique Development, Telemetry-other, ...**8.0268**

MIXING PROCESSES INFLUENCING THE OCEANIC ENVIRONMENT ...Currents-ocean, Density, Mixing, Model Studies, Underwater-construction, ...**2.0054**

MEASUREMENT AND INTERPRETATION OF MOTIONALLY-INDUCED ELECTRIC FIELDS IN THE SEA ...Currents-ocean, Electrical, Forecasting-prediction, Marine Environments-general, Model Studies, Water Motion Recorders, ...**1.0139**

OCEAN DYNAMICS EXPERIMENTS ...Buoys, Other-design-and-construction, Submersibles, Technique Development, Temperature, Water Motion Recorders, ...**2.0072**

OCEAN SYSTEM TELEMETRY STUDY ...Applied Electronics, Buoys, Data Acquisition, Data Transmission Systems, Telemetry-other, ...**4.0002**

DEEP SEA SUBMERSIBLES ...Control-systems, Hull, Life-support-system, Marine Propulsion, Submersibles, ...**8.0292**

OCEANOGRAPHIC RESEARCH ...Acoustical, Hydrodynamics, Instrumentation-general, Naval Architecture-general, Water Motion Recorders, ...**1.0052**

PRECISE RADIO NAVIGATION FOR SHIPS ...Anti-submarine-warfare, Navigation, Navigation Communication, Technique Development, ...**4.0099**

ANCHORS AND MOORINGS ...Submersibles, Technique Development, Underwater-construction, ...**8.0334**

Naval Architecture-general

COLLATION OF POWER PLANT STUDIES ...Diesel, Marine Propulsion, Merchant-ships, ...**8.0161**

DESIGN STUDY - AN OPTIMUM FISHING VESSEL FOR THE GEORGES BANK GROUNDFISH FISHERY ...Atlantic Ocean-north, Commercial Fishing, Computer Applications, Fishing Gear, Other-design-and-construction, ...**8.0288**

ESTIMATION OF HULL STEEL WEIGHTS FROM MIDSHIP SECTION CHARACTERISTICS ...Bulkheads, Engineering Studies-other, Measuring Devices-other, ...**8.0303**

A STUDY OF A TRANSITIONAL CONTAINERSHIP CONCEPT ...Freight, Merchant-ships, Other-design-and-construction, ...**8.0277**

OCEANOGRAPHIC RESEARCH ...Acoustical, Hydrodynamics, Instrumentation-general, Moorings, Water Motion Recorders, ...**1.0052**

EXPLORE FISHERY AND RESEARCH APPLICATIONS OF SUBMARINES ...Other-design-and-construction, Submerged Ships, Submersibles, ...**8.0286**

Navigation Communication

DEVELOPMENT OF A SENSOR, INSTRUMENTATION AND COMMUNICATION SYSTEM FOR A DEEP OCEAN MANNED HABITAT (ATLANTIS) ...Continental Shelf, Ridges, Safety, Submersibles, Underwater-laboratory, ...**8.0107**

DEEP SUBMERGENCE SYSTEMS ...Buoyant, Flotational, Geomorphology-topography, Marine Propulsion, Physical Properties, Submersibles, Welding - Other, ...**8.0051**

SATELLITE INTERROGATE ENVIRONMENTAL BUOY DEVELOPMENT ...Satellites, ...**8.0308**

LOOK-OUT ASSIST DEVICE ...Fog-haze-mist, Navigation, Radar, Visibility, Warning-systems, ...**8.0146**

VLF/OMEGA NAVIGATION ...Communication & Navigation, Control-systems, Navigation, Satellites, ...**4.0106**

TELEMETERING BUOY SYSTEM FOR OCEANOGRAPHIC RESEARCH AND ENIVRONMENTAL PREDICTION ...Buoys, Data Acquisition Systems, Meteorological Studies, Moorings, Oceanography-general, Technique Development, Telemetry-other, ...**8.0268**

PSYCHOPHYSICAL EFFECTS OF XENON FLASHTUBES ...Electronic-flash-lights, Optical Sources, Lamps, Visible, Xenon, ...**8.0053**

DUPLICATE LIMIT STANDARDS FOR SIGNAL COLORS ...Air Traffic Control-other, Colorimetry, Filter, Standards, Specifications, Traffic Control, ...**4.0096**

ADVANCED RESEARCH - SATELLITE INTERROGATED ENVIRONMENTAL BUOY ...Buoys, Meteorological Studies, Satellites, Water Motion Recorders, ...**8.0280**

MICRONESIAN NAVIGATION AND SAILING ...Anthropology-other, Caroline Islands, General Ethnology, Micronesia, Navigation, ...**4.0094**

DEEP RECOVERY SYSTEM ...Operational Aspect, Other-design-and-construction, Recovery Vehicle, Submersibles, ...**8.0267**

PRECISE RADIO NAVIGATION FOR SHIPS ...Anti-submarine-warfare, Moorings, Navigation, Technique Development, ...**4.0099**

DEEP DIVING DECOMPRESSION EQUIPMENT AND TECHNIQUES ...Decompression Sickness, Divers, Diving and Scuba, Medical Studies, Safety, ...**8.0022**

EVALUATION OF CONTEMPORARY PRECISION NAVIGATION SYSTEMS ...Bathymetry, Communication & Navigation, Navigation, Satellites, Technique Development, ...**4.0087**

Operational Aspect

ERROR ANALYSIS OF SEVERAL BOTTOM REFERENCED NAVIGATION SYSTEMS FOR SMALL SUBMERSIBLES ...Error Analysis, Navigation, Sonar, Submersibles, Subsurface Environments, Systems Analysis, ...**4.0111**

SEARCH AND RESCUE - U.S. COAST GUARD ...Consultants, Advisory Services, Economic Theory, Safety, ...**6.0130**

THE EVALUATION AND USE OF SUBMERGED RESEARCH VESSELS IN STUDYING CONTINENTAL SHELF ENVIRONMENTS ...Continental Shelf, Experiments and Tests, Submerged Ships, Submersibles, ...**4.0128**

OPERATION OF BARGE TRAINS IN A SEAWAY ...Barges-towboats, Control-systems, ...**8.0034**

PROPAGATION AND REFRACTION OF OCEAN WAVES IN NEAR SHORE REGIONS ...Forecasting-prediction, Mathematical Analysis, Surface Environments, Waves, ...**2.0117**

OCEAN DYNAMICS EXPERIMENTS ...Atlantic Ocean-north, Buoys, Currents-ocean, Thermal, Waves-internal, ...**2.0071**

CONTROL OF SUPERCONDUCTING MACHINES FOR SHIP PROPULSION ...Engineering Studies-general, Marine Propulsion, Mathematical Analysis, Model Studies, ...**8.0301**

OPTIMIZATION METHOD APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL SALVAGE TUG ...Algorithms, Design of Experiments, Optimization Technique, Other-design-and-construction, Random Variables, ...**8.0307**

SHIP DESIGN WAVE RESEARCH ...Other-design-and-construction, Waves, ...**8.0291**

DEEP RECOVERY SYSTEM ...Navigation Communication, Other-design-and-construction, Recovery Vehicle, Submersibles, ...**8.0267**

SURVIVAL CRAFT DRIFT AND LEEWAY ...Air Motion Instruments, Buoys, Currents-ocean, Equipment, Ocean-lakes, Tables, Compilations, Catalogs, ...**6.0129**

Recovery Vehicle

DEEP RECOVERY SYSTEM ...Navigation Communication, Operational Aspect, Other-design-and-construction, Submersibles, ...**8.0267**

Safety

DEVELOPMENT OF A SENSOR, INSTRUMENTATION AND COMMUNICATION SYSTEM FOR A DEEP OCEAN MANNED HABITAT (ATLANTIS) ...Continental Shelf, Navigation Communication, Ridges, Submersibles, Underwater-laboratory, ...**8.0107**

UNDERWATER WELDING ...Helium, Inert Gas, Materials Used Undersea, Scientific-service-support, Subsurface Environments, ...**8.0344**

SEARCH AND RESCUE - U.S. COAST GUARD ...Consultants, Advisory Services, Economic Theory, Operational Aspect, ...**6.0130**

SEAKEEPING QUALITIES - MOTIONS AND POWERING PREDICTIONS ...Merchant-ships, Ship Resistance Stability, Waves, ...**8.0306**

SHIP MANEUVERING AND CONTROL ...Control-systems, Merchant-ships, Moorings, Tankers, ...**8.0313**

HUMAN FACTORS IN SHIP CONTROL ...Bridge, ...**8.0272**

MOORING IMPROVEMENT SYSTEM ...Moorings, ...**8.0316**

EXPERIMENTAL COMMERCIAL OPERATION OF SAVANNAH ...Merchant-ships, Nuclear, Other-design-and-construction, ...**12.0035**

ADVANCED NUCLEAR CARGO SHIP ...Control-systems, Merchant-ships, Nuclear, Other-design-and-construction, ...**8.0274**

MERCHANT SHIP REACTOR PRELIMINARY SAFETY ANALYSIS ...Merchant-ships, Nuclear, ...**8.0167**

STRUCTURAL DESIGN CRITERIA ...Flaw Detection - Other, Hull, Hydrodynamic Structures, Process Control, Stress Concentration-toughness, ...**8.0283**

POWER SOURCES ...Benthonic-bottom, Power Transmission Systems, Submerged Ships, Technique Development, Underwater-construction, ...**8.0156**

DESIGN AND CONSTRUCTION ...Coatings-general, Environmental Effects-geologic, Hydrodynamic Structures, Underwater-construction, Water, ...**8.0333**

SUBMARINE MEDICINE ...Life-support-system, Naval Personnel, Occupational Hazards, Ordnance, ...**8.0018**

DEEP DIVING DECOMPRESSION EQUIPMENT AND TECHNIQUES ...Decompression Sickness, Divers, Diving and Scuba, Medical Studies, Navigation Communication, ...**8.0022**

MECHANIZATION OF TRAWL GEAR ...Commercial Fishing, Fishing Gear, ...**8.0135**

Scientific-service-support

RESEARCH SUBMARINE BEAVER MK IV ...Control-systems, Diving and Scuba, Submersibles, Technique Development, Underwater-laboratory, ...**8.0265**

UNDERWATER WELDING ...Helium, Inert Gas, Materials Used Undersea, Safety, Subsurface Environments, ...**8.0344**

RESEARCH ADVISORY SERVICES ...Administration & Management, Freight, Loading/unloading, Water Transportation, ...**12.0014**

APPLIED MARINE ENGINEERING PROGRAM AT SCRIPPS INSTITUTION OF OCEANOGRAPHY ...California, Engineering Studies-general, Harbors, Marine Biology, Marine Biology (non-specific), Other-design-and-construction, Teaching and Research, Training Grants, Fellowships, ...**11.0006**

RESEARCH VESSEL U.S.N.S ELTANIN ...Antarctica, Equipment Purchase Operation, Geophysics-general, Special Mission Ships, Teaching and Research, ...**12.0036**

SHIPBOARD GRAVITY SENSOR AND GYROCOMPASS ...Equipment Purchase Operation, Geophysical Equipment, Gryo, ...**8.0103**

HUDSON LABORATORIES SHIP SUPPORT ...Acoustical, Facilities, Modification-conversion, Platforms, Ships and Cruises, Special Mission Ships, ...**12.0021**

DEEP OCEAN ENGINEERING TECHNOLOGY ...Abyssal, Benthonic-bottom, Buoys, Experiments and Tests, Facilities, Platforms, ...**8.0270**

DEEP SEA MINING PROJECT ...Dredging, Equipment, Ocean Mining, Technique Development, ...**8.0259**

ARCTIC SUPPORT ...Arctic, Remote Sensing-general, Sea Ice, Submerged Ships, ...**3.0080**

SUPPORTING SYSTEMS ...Facilities, Underwater-laboratory, ...**8.0338**

BACKGROUND AND EXPLORATORY STUDIES OF MATERIALS HANDLING IN THE MARINE ENVIRONMENT ...Equipment, Freight, Ocean Mining, Pipelines, Rock Fragmentation Methods, ...**8.0258**

LABORATORY STUDIES TO CORRELATE ENGINEERING PROPERTIES OF MARINE PLACER MATERIALS WITH SAMPLING TOOL PERFORMANCE ...Coring and Dredging, Gold, Laboratory Analysis, Mechanical Properties, Placer, ...**8.0244**

Ship Motion & Dynamics

ROLL DISTRIBUTION OF A NUCLEAR CARGO SHIP WITH AND WITHOUT FLUME STABILIZATION ...Merchant-ships, Nuclear, Other-design-and-construction, Ship Resistance Stability, ...**8.0319**

Ship Resistance Stability

HYDRODYNAMIC FLOW FIELD STUDY ...Programming, Viscous, Wave, ...**8.0170**
SEAKEEPING QUALITIES - MOTIONS AND POWERING PREDICTIONS ...Merchant-ships, Safety, Waves, ...**8.0306**
ROLL DISTRIBUTION OF A NUCLEAR CARGO SHIP WITH AND WITHOUT FLUME STABILIZATION ...Merchant-ships, Nuclear, Other-design-and-construction, Ship Motion & Dynamics, ...**8.0319**
AN INVESTIGATION OF THE PERFORMANCE OF A COLUMN STABILIZED PLATFORM ...Engineering Studies-other, Experiments and Tests, Models, Platforms, ...**8.0296**
A DUAL MODE ROLE STABILIZATION SYSTEM ...Applications, Control-systems, Development of Models, Models, Submersibles, ...**8.0302**
VORTEX WAKE SHEDDING OF A HEAVING CIRCULAR CYLINDER ...Configuration of Body, Dimension-two, Reynolds Number, Vortex, Wake, ...**8.0191**
FLUID MECHANICS RESEARCH ...Forecasting-prediction, Hydrodynamics, Industrial Engineering, Waves, ...**8.0176**

Ship-design-&-construction

Barges-towboats
OPERATION OF BARGE TRAINS IN A SEAWAY ...Control-systems, Operational Aspect, ...**8.0034**
TRANSOCEAN TUG-BARGE FEASIBILITY ...Connectors, Freight, Other-design-and-construction, ...**8.0030**
CATAMARAN CONTAINERSHIP FEASIBILITY ...Computer Applications, Freight, Models, Storage, ...**8.0273**
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PRESISTANCE AND PROPULSION HUL CONFIGURATION ...Marine Propulsion, Merchant-ships, Stern, ...**8.0310**

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HULL DESIGN - MODULAR DECKHOUSE ...Merchant-ships, Prefabricated, ...**8.0318**
HUMAN FACTORS IN SHIP CONTROL ...Safety, ...**8.0272**

Bulkheads
SHIP STRUCTURE LABORATORY TESTING AND ANALYSES ...Experiments and Tests, Hull, Hydrodynamic Structures, Models, ...**8.0261**
INVESTIGATION OF NAVAL SHIP FORMS ...Engineering Studies-other, Military Aspects, ...**8.0300**
A STUDY OF THE INTERFACE LOCATIONS BETWEEN DISSIMILAR MATERIALS AND OTHER ASPECTS OF A COMPOSITE MIDSHIP SECTION ...Hull, Hydrodynamic Structures, Strength, ...**8.0294**
EFFECTS OF MATERIAL VARIATIONS IN THE COMPUTERIZED DESIGN OF PRIMARY HULL STRUCTURE ...Computer Applications, Engineering Studies-other, Low Alloy Steels, Materials Used Undersea, Strength, Cohesion, ...**8.0298**
ESTIMATION OF HULL STEEL WEIGHTS FROM MIDSHIP SECTION CHARACTERISTICS ...Engineering Studies-other, Measuring Devices-other, Naval Architecture-general, ...**8.0303**

Hull
SHIP STRUCTURE LABORATORY TESTING AND ANALYSES ...Bulkheads, Experiments and Tests, Hydrodynamic Structures, Models, ...**8.0261**
FULL SCALE STRESS MEASUREMENT TESTS OF GREAT LAKES ORE CARRIER ...Great Lakes-general, Other-design-and-construction, Testing Structural, Waves, ...**8.0320**
THE FEASIBILITY OF REDUCED CARGO GEAR INSTALLATION ONBOARD BREAK-BULK CARGO SHIPS ...Loading/unloading, Material Handling Devices, Merchant-ships, ...**8.0035**
STRUCTURAL DESIGN CRITERIA ...Flaw Detection - Other, Hydrodynamic Structures, Process Control, Safety, Stress Concentration-toughness, ...**8.0283**
DEEP SEA SUBMERSIBLES ...Control-systems, Life-support-system, Marine Propulsion, Moorings, Submersibles, ...**8.0292**
A STUDY OF THE INTERFACE LOCATIONS BETWEEN DISSIMILAR MATERIALS AND OTHER ASPECTS OF A COMPOSITE MIDSHIP SECTION ...Bulkheads, Hydrodynamic Structures, Strength, ...**8.0294**
WEIGHT ANALYSIS IN FISHING BOATS ...Approximations, Low Alloy Steels, Measuring Devices-other, Pressure Effects, ...**8.0295**
METAL ANALYSIS/TEST INSPECTION ...Flaw Detection - Other, Materials Used Undersea, Penetrating Ray, Standards, Specifications, Ultrasonic and Sonic, ...**8.0218**

Maintenance-system
FRICTIONAL RESISTANCE HULL SCALE AND COATINGS ...Corrosion General, Materials Used Undersea, Paint - General, Wear, Friction, ...**8.0227**
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SWIMMER HIGH DEFINITION SONAR ...Diving and Scuba, Diving-system, Engineering Studies-other, Sonar, Underwater-construction, ...**8.0019**

Modification-conversion
CONTRAROTATING PROPELLER IN JUMBOIZED MARINER ...Merchant-ships, Models, Rotors-propellers, ...**8.0290**
TRANSITIONAL CONTAINERSHIP CONCEPT ...Freight, Merchant-ships, Other-design-and-construction, ...**8.0317**
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HUDSON LABORATORIES SHIP SUPPORT ...Acoustical, Facilities, Platforms, Scientific-service-support, Ships and Cruises, Special Mission Ships, ...**12.0021**

Other-design-and-construction
PASSIVE BUOYANCY SYSTEMS ...Buoyant, Flotational, Engineering Studies-general, Foam, Porous, Materials Used Undersea, Submersibles, ...**8.0263**
FULL SCALE STRESS MEASUREMENT TESTS OF GREAT LAKES ORE CARRIER ...Great Lakes-general, Hull, Testing Structural, Waves, ...**8.0320**
SHIPBUILDING COST ESTIMATING METHODOLOGY ...Facilities, ...**8.0271**
TRANSOCEAN TUG-BARGE FEASIBILITY ...Barges-towboats, Connectors, Freight, ...**8.0030**
TRANSITIONAL CONTAINERSHIP CONCEPT ...Freight, Merchant-ships, Modification-conversion, ...**8.0317**
COMPETITIVE MERCHAND SHIP (BULK) TECHNICAL INNOVATIONS ...Freight, Merchant-ships, Water Vessel, ...**4.0064**
EXPERIMENTAL COMMERCIAL OPERATION OF SAVANNAH ...Merchant-ships, Nuclear, Safety, ...**12.0035**
ADVANCED NUCLEAR CARGO SHIP ...Control-systems, Merchant-ships, Nuclear, Safety, ...**8.0274**
ROLL DISTRIBUTION OF A NUCLEAR CARGO SHIP WITH AND WITHOUT FLUME STABILIZATION ...Merchant-ships, Nuclear, Ship Motion & Dynamics, Ship Resistance Stability, ...**8.0319**
DIGEST OF THE ADVANCED NUCLEAR CARGO SHIP STUDY ...Freight, Merchant-ships, Nuclear, ...**8.0275**
OCEANOGRAPHIC ENGINEERING ...Bathythermographs, Engineering Studies-other, Experiments and Tests, Platforms, Special Mission Ships, ...**8.0269**
APPLIED MARINE ENGINEERING PROGRAM AT SCRIPPS INSTITUTION OF OCEANOGRAPHY ...California, Engineering Studies-general, Harbors, Marine Biology, Marine Biology (non-specific), Scientific-service-support, Teaching and Research, Training Grants, Fellowships, ...**11.0006**
OCEAN DYNAMICS EXPERIMENTS ...Buoys, Moorings, Submersibles, Technique Development, Temperature, Water Motion Recorders, ...**2.0072**
DESIGN STUDY - AN OPTIMUM FISHING VESSEL FOR THE GEORGES BANK GROUNDFISH FISHERY ...Atlantic Ocean-north, Commercial Fishing, Computer Applications, Fishing Gear, Naval Architecture-general, ...**8.0288**
FISHING VESSEL CONSTRUCTION COSTS AND THE U.S. FISHING VESSEL CONSTRUCTION DIFFERENTIAL SUBSIDY ...Commercial Fishing, Costs, Economics, Fiscal, Surface Ships, ...**4.0181**
DESIGN AND CONSTRUCTION OF BARGE AND CLAM DREDGE FOR SURVEY OF FLORIDA'S COMMERCIAL

CLAMS ...Clams, Commercial Fishing, Florida, Habitat Studies, ...8.0284

OPTIMIZATION METHODS APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL AUXILIARY ...Algorithms, Cost Analysis, Engineering Studies-other, Optimization Technique, Requirement, ...8.0297

HETERODYNE MEASUREMENTS OF ATMOSPHERIC PHASE TURBULENCE AT 6328A ...Heterodyne System, Phase, Transmission, Turbulence, ...8.0190

OPTIMIZATION METHOD APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL SALVAGE TUG ...Algorithms, Design of Experiments, Operational Aspect, Optimization Technique, Random Variables, ...8.0307

A STUDY OF A TRANSITIONAL CONTAINERSHIP CONCEPT ...Freight, Merchant-ships, Naval Architecture-general, ...8.0277

SHIP DESIGN WAVE RESEARCH ...Operational Aspect, Waves, ...8.0291

DEEP RECOVERY SYSTEM ...Navigation Communication, Operational Aspect, Recovery Vehicle, Submersibles, ...8.0267

PELAGIC TRAWL ...Nets, Oceanic - Pelagic, Special Mission Ships, ...8.0134

EXPLORE FISHERY AND RESEARCH APPLICATIONS OF SUBMARINES ...Naval Architecture-general, Submerged Ships, Submersibles, ...8.0286

Stern

PROPULSION EFFICIENCY 'U' VERSUS 'V' STERNS ...Marine Propulsion, Shock-vibration, ...8.0289

PRESISTANCE AND PROPULSION HUL CONFIGURATION ...Bow, Marine Propulsion, Merchant-ships, ...8.0310

Tankers

SHIP MANEUVERING AND CONTROL ...Control-systems, Merchant-ships, Moorings, Safety, ...8.0313

SECOND HAND PRICES FOR TANKERS ...Economics, Model Studies, Price & Value, Trends,projections, ...4.0184

Shock-vibration

PROPULSION EFFICIENCY 'U' VERSUS 'V' STERNS ...Marine Propulsion, Stern, ...8.0289

VARIABLE PRESSURE WATER TUNNEL RESEARCH ...Cavity Flow, Facilities, Hydrofoils Crafts, Marine Propulsion, Sound Field, Water Tunnels Tables, ...8.0183

Special Mission Ships

AN IMPROVED MARINE VIBROSEOS INSTALLATION ...Data Acquisition, Hydrographic, Sonar, ...8.0166

MARINE DIGITAL GRAVITY PROFILING SYSTEM ...Digital Computer Applications, Field Characteristics-general, Gravity Studies, Navigation, ...4.0038

OCEANOGRAPHIC ENGINEERING ...Bathythermographs, Engineering Studies-other, Experiments and Tests, Other-design-and-construction, Platforms, ...8.0269

LENGTHENING AND INCREASING OCEANOGRAPHIC CAPABILITES OF R/V ACONA ...Equipment Purchase Operation, Modification-conversion, Oceanography-general, Pacific Ocean-north, Shoreline - Coastline, ...12.0002

RESEARCH VESSEL U.S.N.S ELTANIN ...Antarctica, Equipment Purchase Operation, Geophysics-general, Scientific-service-support, Teaching and Research, ...12.0036

PRECISION MEASUREMENTS OF DISSOLVED OXYGEN, NITROGEN AND ARGON IN SEAWATER ...Argon, Gases, Nitrogen, Oxygen, Particle-gas Transfer, Solubility, ...1.0092

HUDSON LABORATORIES SHIP SUPPORT ...Acoustical, Facilities, Modification-conversion, Platforms, Scientific-service-support, Ships and Cruises, ...12.0021

MECHANICAL PROPERTIES ...Environment General, Liquid, Mechanical Properties, Submersibles, Test Methods, ...8.0210

PELAGIC TRAWL ...Nets, Oceanic - Pelagic, Other-design-and-construction, ...8.0134

OPERATIONAL EVALUATION OF NSRT SYSTEM ...Equipment, Surface Environments, Temperature, ...8.0059

Submerged Ships

THE EVALUATION AND USE OF SUBMERGED RESEARCH VESSELS IN STUDYING CONTINENTAL SHELF ENVIRONMENTS ...Continental Shelf, Experiments and Tests, Operational Aspect, Submersibles, ...4.0128

COLLECTION, ANALYSIS, INTERPRETATION, AND PRESENTATION OF OCEANOGRAPHIC - GEOLOGIC DATA IN CONNECTION WITH SUBMARINE CABLE SYSTEM DEVELOPMENT ...Cables and Transmission Lines, Data Acquisition, Data Analysis - General, Transmission Lines, ...7.0043

STEP RESPONSE METHOD FOR DETERMINING HORIZONTAL COEFFICENT FOR DEEP SUBMERSIBLES ...Models, Submersibles, ...8.0293

OCEAN DYNAMICS IN THE STRAITS OF GIBRALTAR AND ADJACENT AREAS ...Acoustical, Anti-submarine-warfare, Computer Applications, Hydrodynamics, Model Studies, Strait of Gibraltar, ...1.0141

ARCTIC SUPPORT ...Arctic, Remote Sensing-general, Scientific-service-support, Sea Ice, ...3.0080

BUOYANCY MATERIALS ...Buoyant, Flotational, Materials Used Undersea, Microsphere, Microballoon, Plastic Matrix, ...8.0214

POWER SOURCES ...Benthonic-bottom, Power Transmission Systems, Safety, Technique Development, Underwater-construction, ...8.0156

CONSTRUCTION SYSTEMS ...Benthonic-bottom, Engineering Studies-other, Equipment, Underwater-construction, ...8.0120

EXPLORE FISHERY AND RESEARCH APPLICATIONS OF SUBMARINES ...Naval Architecture-general, Other-design-and-construction, Submersibles, ...8.0286

Surface Ships

SURFACE EFFECT SHIP ECONOMIC OPPORTUNITY ...Flow, Freight, Origin-destination Studies, ...8.0028

WAVE AND SURGE ACTION STUDY FOR LOS ANGELES-LONG BEACH HARBORS ...California, Harbors, Models, Wave Action, Waves, ...2.0098

FISHING VESSEL CONSTRUCTION COSTS AND THE U.S. FISHING VESSEL CONSTRUCTION DIFFERENTIAL SUBSIDY ...Commercial Fishing, Costs, Economics, Fiscal, Other-design-and-construction, ...4.0181

Underwater-construction

STABLE OCEANIC STATION ...Engineering Studies-other, Floating Structure Stability, Platforms, ...8.0287

SEA BED INSTALLATION ...Benthonic-bottom, Deep, Diving and Scuba, Stabilization, Submersibles, ...8.0331

MIXING PROCESSES INFLUENCING THE OCEANIC ENVIRONMENT ...Currents-ocean, Density, Mixing, Model Studies, Moorings, ...2.0054

SATURATED DIVING FACILITIES FOR DIVER-SCIENTIST AND RELATED RESEARCH ...Controls, Data Acquisition, Marine Environments-general, Model Studies, Submersibles, Underwater-laboratory, ...8.0311

DEEP OCEAN SYSTEMS ...Diving and Scuba, Diving-system, Submersibles, ...8.0339

SWIMMER HIGH DEFINITION SONAR ...Diving and Scuba, Diving-system, Engineering Studies-other, Maintenance-system, Sonar, ...8.0019

POWER SOURCES ...Benthonic-bottom, Power Transmission Systems, Safety, Submerged Ships, Technique Development, ...8.0156

DESIGN AND CONSTRUCTION ...Coatings-general, Environmental Effects-geologic, Hydrodynamic Structures, Safety, Water, ...8.0333

ANCHORS AND MOORINGS ...Moorings, Submersibles, Technique Development, ...8.0334

CONSTRUCTION SYSTEMS ...Benthonic-bottom, Engineering Studies-other, Equipment, Submerged Ships, ...8.0120

Underwater-laboratory

DEVELOPMENT OF A SENSOR, INSTRUMENTATION AND COMMUNICATION SYSTEM FOR A DEEP OCEAN MANNED HABITAT (ATLANTIS) ...Continental Shelf, Navigation Communication, Ridges, Safety, Submersibles, ...8.0107

DEEP SUBMERGENCE VEHICLES - DYNAMIC ANALYSES ...Data Acquisition, Experiments and Tests, Mathematical Analysis, Model Studies, Submersibles, Technique Development, ...8.0264

RESEARCH SUBMARINE BEAVER MK IV ...Control-systems, Diving and Scuba, Scientific-service-support, Submersibles, Technique Development, ...8.0265

ENVIRONMENTAL PHYSIOLOGY ...Diving and Scuba, Life-support-system, Medical Studies, Pressure, Submersibles, ...6.0093

SATURATED DIVING FACILITIES FOR DIVER-SCIENTIST AND RELATED RESEARCH ...Controls, Data Acquisition, Marine Environments-general, Model Studies, Submersibles, Underwater-construction, ...8.0311

SHALLOW WATER OCEANOGRAPHY (SEALAB III) ...Diving and Scuba, Diving-system, Environmental Effects-geologic, Instrumentation-general, ...1.0146

SUPPORTING SYSTEMS ...Facilities, ...8.0338

Ventilated Flow

EXPERIMENTAL INVESTIGATION OF VENTILATED CAVITIES ...Facilities, Pulsating, Rotors-propellers, Ventilated Cavities, ...8.0185

Yards-docks

MODEL FOR PRELIMINARY EVALUATION OF TOTAL CARGO TRANSPORTATION TIME AND TRANSPORTATION COST FOR ADVANCED CARGO TRANSPORTATION SYSTEMS ...Computer Applications, Costs, Freight, Transportation Systems, ...4.0067

Navigation

NAVIGATION RECEIVER ...Navigation Systems-other, Radio, Sonar, Transducers, Transponders, ...4.0112

ERROR ANALYSIS OF SEVERAL BOTTOM REFERENCED NAVIGATION SYSTEMS FOR SMALL SUBMERSIBLES ...Error Analysis, Operational Aspect, Sonar, Submersibles, Subsurface Environments, Systems Analysis, ...4.0111

INTEGRATION OF DOPPLER SATELLITE AND LORAC NAVIGATIONAL SERVICES ...Doppler, Loran, Satellites, ...4.0110

MARINE DIGITAL GRAVITY PROFILING SYSTEM ...Digital Computer Applications, Field Characteristics-general, Gravity Studies, Special Mission Ships, ...4.0038

LOOK-OUT ASSIST DEVICE ...Fog-haze-mist, Navigation Communication, Radar, Visibility, Warning-systems, ...8.0146

VHF SATELLITE COMMUNICATIONS ...Range and Tracking-other, Space Crafts, Very High Frequency, ...4.0105

IMPROVED STANDARDS FOR RADIO AND ELECTRONIC EQUIPMENT ...Instrumental Services, ...4.0093

MARINE GRAVITY ...Gravity Studies, Gravity Surveys, Satellites, Variations, ...4.0107

OCEAN CURRENT TRANSPORT ...Gulf Stream, Ocean Waves - Currents, Water Motion Recorders, ...2.0016

MARINE PHYSICAL GEODESY ...Aerospatial, Caribbean Sea, Gravity Studies, Sea Level Variations, Standard Geoid, ...4.0058

GRAVITY ...Anomalies, Caribbean Sea, Geophysical Equipment, Gravity, Pacific Ocean-west, ...7.0142

STUDIES OF THE TRANSPORT OF THE FLORIDA CURRENT ...British West Indies, Florida, Gulf Stream, Ocean Currents-other, Water Motion Recorders, ...2.0017

MARINE GRAVITY ...Analog Computer Applications, Geophysical Equipment, Gravity Studies, Satellites, Ships and Cruises, Technique Development, ...7.0128

DEVELOPMENT OF AN ADVANCED MISSILE IMPACT LOCATING SYSTEM FOR THE EASTERN TEST RANGE ...Acoustical, Area, Atlantic Ocean-north, Missile & Rockets, Sound Gear, ...8.0048

INSTRUMENT DEVELOPMENT ...Oxygen, Satellites, Technique Development, ...8.0065

VLF/OMEGA NAVIGATION ...Communication & Navigation, Control-systems, Navigation Communication, Satellites, ...4.0106

DEVELOPMENT OF A PHOTOGRAPHIC SUIT FOR STEREOPHOTOGRAMMETRIC MAPPING BY SUMBERSIBLE ...Mapping, Photography, Sonar, Submersibles, Turkey, ...4.0060

BIOMETRY ...Marine Biology, Population Dynamics, Statistics-general, Temporal Distribution, ...4.0019

MARINE GRAVITY ...Dynamic Gravimeters, Geophysical Equipment, Ships and Cruises, Technique Development, ...8.0101

GRAVITY FIELD AT SEA ...Gravity Studies, Pacific Ocean-south, Ships and Cruises, Variations, ...7.0098

WOODS HOLE SHIPBOARD DATA PROCESSING ...Data Reduction and Analysis, Digital Computer Applications, Gravity Studies, Magnetic Studies, Real Time Systems, ...4.0031

WWV BROADCASTS ...Signal Generators, ...4.0089

SATELLITE TIME DISSEMINATION ...Airborne Probing, Communication & Navigation, Doppler, Signal Generators, Standards, Specifications, Time Measurements, ...4.0091

WWVB-WWVL BROADCASTS ...Frequency Standards, Low Frequency, Radio, Signal Generators, Standards, Specifications, Time Measurements, Very Low Frequency, ...4.0090

VLF TIMING STUDIES ...Attenuation, Absorption, Electromagnetic Transmission, Standards, Specifications, Time Measurements, Very Low Frequency, ...4.0092

MICRONESIAN NAVIGATION AND SAILING ...Anthropology -other, Caroline Islands, General Ethnology, Micronesia, Navigation Communication, ...4.0094

NAVIGATION SYSTEMS FOR SURVEY APPLICATIONS ...Area, Instrumentation, Technique Development, ...4.0101

PRECISE RADIO NAVIGATION FOR SHIPS ...Anti-submarine-warfare, Moorings, Navigation Communication, Technique Development, ...4.0099

SONIC UNDERWATER NAVIGATION FOR SHIPS ...Equipment, Instrumentation-other, Ranging, Sonar, Sound Gear, ...4.0100

DIVER NAVIGATION DEVICE ...Bathymetry, Diving and Scuba, Diving-system, Technique Development, ...6.0131

HARBOR DESIGN STUDIES ...Harbors, Waves, ...8.0046

EVALUATION OF CONTEMPORARY PRECISION NAVIGATION SYSTEMS ...Bathymetry, Communication & Navigation, Navigation Communication, Satellites, Technique Development, ...4.0087

Navigation Systems

Loran

INTEGRATION OF DOPPLER SATELLITE AND LORAC NAVIGATIONAL SERVICES ...Doppler, Navigation, Satellites, ...4.0110

Navigation Systems-other

NAVIGATION RECEIVER ...Navigation, Radio, Sonar, Transducers, Transponders, ...4.0112

BIOLOGICAL INSTRUMENTATION ...Behavioral Ecology, Biological Sciences, Instrumental Services, Instrumentation-general, ...8.0064

Nektonic - Swimming

DESIGN AND DEVELOPMENT OF NEKTON SAMPLER ...Food Supply, Organism Sampling Devices, Plankton Sampling, Tuna, Mackerel, Albacore... , ...8.0129

Nematodes

Animal Nematodes -non-specific

FREEZING AND DRYING OF LIVING CELLS ...Cell Injury and Autolysis, Cell. env.(non-specific & Ot.), Freeze-dry Techniques, Mollusks -non-specific & Other, Tissue Techniques, ...5.0450

Nematoda -other

MARINE NEMATODES OF THE CAPE COD AREA ...Animal Taxonomy, Collections, Habitat Studies, Northeast, ...5.0566

COMPARATIVE MORPHOLOGY OF MARINE NEMATODES ...Comparative Physiology, Histology and Cytology, Invertebrate Anatomy, Musculoskeletal System, ...5.0567

WATER QUALITY AND FUNGI-NEMATODE-SEAGRASS RELATIONSHIPS ...Elodea, Waterweed, Thalassia, Florida, Habitat Studies, Marine Fungi (non-specific), ...5.0878

Red Worms, Eye Works...

SYSTEMATIC STUDIES OF CERTAIN MARINE PARASITIC WORMS ...Animal Taxonomy, Helminths, Life History Studies, Trematoda -other, ...5.0541

Nervous System

Basic Studies

Chem and Metab

CHEMISTRY AND FUNCTION OF BRAIN PLASMALOGENS ...Comparative Physiology, Molec. struct. (gen. & Other), Phospholipids, Plasmalogen, ...5.1003

Mech of Transmission

METABOLISM OF NEUROHUMORAL TRANSMITTER SUBSTANCES IN MARINE ANIMALS ...Animal Toxins, Basic Studies, Metabolic Inhibitors, Structural Functions, ...5.0981

NEURAL MECHANISMS OF LEARNING AND BEHAVIOR ...Behavior, Brain, Gastropods -slugs,conch,snails, Learning and Retention, ...5.0485

Pathways

SENSORY PROCESSES, MARINE AND HUMAN ...Bioelectric Phenomena, Nervous System, Sensory Organs, Visual, ...5.0969

SENSORY PROCESSES ...Basic Studies, Hawaii, ...5.0595

Structure-cell-tiss

THE CETACEAN BRAIN - A COMPARATIVE STUDY ...Central Nervous System, Comparative Physiology, Mammals, ...5.0641

Nerve Effects

THE EFFECT OF SOME NEUROTRAMSMITTERS ON THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Brain, Cardiovascular, Horseshoe Or King Crabs, Neuroeffective, ...5.0470

SUPPORT FOR THE PHYSIOLOGICAL RESEARCH SHIP, R/V ALPHA HELIX ...Insecticides -non-specific, Mycorrhiza, Rain Forests, Regulation, Tropic, ...12.0011

New Hampshire

(A) ANNUAL SUPPLY OF PARTICULATE MATTER IN THE GREAT BAY ESTUARY (B) LATE PLEISTOCENE HISTORY OF THE GREAT ...Estuaries, Organics, Quaternary Period, Sampling, Sedimentary History, ...1.0155

New Jersey

CREEL CENSUS OF SUMMER FLOUNDER SPORT FISHERY IN GREAT BAY, NEW JERSEY ...Bays, Censusing, Lefteye Flounders, Legislation, Life History Studies, ...5.0124

STRATIGRAPHY OF RECENT INTERTIDAL SEDIMENTMENTARY DEPOSITS OF THE SHEEPSHEAD MUDFLAT, NEW JERSEY ...Intertidal Areas, Quaternary Period, Sediments-other, Stratigraphy-general, ...7.0274

PURIFICATION OF HARD CLAMS FROM POLLUTED WATERS ...Animal Viruses (non-specific), Clams, Contamination - Water, Estuaries, Intestinal Bacteria, ...5.0467

New York

INSTRUEMTATION FOR LAKE CAYUGA HEAT RELEASE STUDY ...Electric Power Plants, Heat Flow, Lakes, Temperature, Thermal Pollution, ...8.0105

POTENTIALLY-ECONOMIC SAND AND SILT DEPOSITS IN LAKE ONTARIO, NEW YORK ...Geologic Maps, Lake Ontario, Potential of Deposit, Sands and Gravels, Submergent, ...7.0024

CHANGES IN THE LIMITING NUTRIENT DUE TO TEMPORAL, GEOGRAPHIC, AND DEPTH VARIATIONS ...Depth, Nutrients, Phytoplankton, Sub - Tropic, Water Depth, Water Levels, ...5.1004

SUPPORT OF THE MARINE BIOLOGY PROGRAM AT THE LAMONT GEOLOGICAL OBSERVATORY ...Equipment Purchase Operation, Marine Biology, ...11.0033

PROJECT AQUA-MAP - DEVELOPMENT OF AERIAL PHOTOGRAPHY AS AN AID TO WATER QUALITY MANAGEMENT ...Aerial Photography, Effluents-waste Water, Management, Model Studies, Pollutants-other, ...4.0167

ECOLOGICAL FACTORS AFFECTING REPRODUCTION OF SHELLFISH (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...Animal Distr. (non-specific), Maturity & Growth Stages, Oysters, Reproductive System, Spawning & Nesting Sites, ...5.0374

New Zealand

A SYSTEMATIC STUDY OF ENTOCYTHERID OSTRACODS ...Animal Taxonomy, Madagascar-malagasy Republic, Publications -other, Shrimps - Seed Or Mussel, South America, ...5.0492

Nicaragua

DISTRIBUTION AND MIGRATION OF CENTRAL AMERICAN FRESHWATER ELASMOBRANCHS ...Caribbean Sea, Migration, Osmoregulation, Rays, Skates, Mantas, Sawfish, Sharks, ...5.0117

Nickel

EFFECT OF INTERFIBER SPACING ON THE HIGH TEMPERATURE DEFORMATION OF A1-A13NI COMPOSITES ...Aluminum, Intermetallic Compound, Metal Matrix, Plasticity, Tensile, ...8.0229

PRODUCTION OF PLATES OF FIBER COMPOSITES BY SOLIDIFICATION, FORMING AND A COMBINATION OF BOTH ...Aluminum, Fiber, Filament, Intermetallic Compound, Metal Matrix, Orientation, ...8.0230

TEMPERATURE AND STRAIN RATE DEPENDENCE OF DEFORMATION IN AL-3NI-AL COMPOSITES ...Aluminum, Deformation - General, Intermetallic Compound, Metal Matrix, Strain Rate, ...8.0231

Nitrate, Nitrite

DYNAMICS OF THE NITROGEN CYCLE IN THE SEA ...General Sea Water Chemistry, Nitrogen, Nitrogen Fixation, Tracers, ...5.0933

AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE ...Management, Phosphate, Phosphite, Swamps-marshes, Tidewater Areas, Water Properties-general, ...5.0953

NUTRIENT REQUIREMENTS OF ALGAE ...Algal Culture, Cyanophyta (non-specific & Ot), Nutrition Studies, Phosphate, Phosphite, ...5.0706

Nitrogen

COMPARATIVE STUDY OF NITROGEN SECRETION IN FISHES ...Comparative Physiology, Fish, Metabolism, Vertebrate Anatomy, ...5.1022

DYNAMICS OF THE NITROGEN CYCLE IN THE SEA ...General Sea Water Chemistry, Nitrate, Nitrite, Nitrogen Fixation, Tracers, ...5.0933

PRECISION MEASUREMENTS OF DISSOLVED OXYGEN, NITROGEN AND ARGON IN SEAWATER ...Argon, Gases, Oxygen, Particle-gas Transfer, Solubility, Special Mission Ships, ...1.0092

AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE - LABORATORY PROCEDURES ...Colorimetry, Computer Applications, Conductrometry, Management, Phosphate, Phosphite, Swamps-marshes, ...5.0761

BIOLOGICAL AND CHEMICAL STUDY OF VIRGINIA'S ESTUARIES ...Estuaries, Phosphorus, Phytoplankton, Population Dynamics, Primary Productivity, Virginia, ...1.0158

NUTRIENT ASSIMILATION RATES - FIELD STUDIES ...Estuaries, Nitrogen Cycle, Nutrients, Phosphorus, Tracers-general, ...5.0990

ECOLOGY AND NITROGEN CYCLE IN A MARINE PLANT COMMUNITY ...Bering Sea, Physiological Ecology, Potamogeton, Ruppia, Zostera.., Primary Productivity, Sewage, ...5.0676

BACTERIOLOGICAL STUDY OF THE POLLUTION OF KANEOHE BAY, OAHU ...Bays, Bioindicators, Coliforms (non-specific), Hawaii, Sewage, Streptococcus Fecalis, ...6.0150

THE THERMODYNAMIC PROPERTIES OF NITROGEN-OXYGEN MIXTURES ...Critical, Enthalpy, Entropy, Oxygen, State Equations, Survey Studies, ...8.0025

STUDIES ON INORGANIC NUTRIENT ASSIMILATION RATES IN ESTUARINE PONDS ...Estuaries, Mineral Content -water, Nutrients, Phosphorus, Self-purification, ...5.0991

EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...Aquatic Ecology, Columbia River, Gases, Dissolved -water, Migration, Mortality Rates, Salmon & Trout - Non-specific, ...5.0221

Nitrogen

NITROGEN METABOLISM IN MOLLUSCS ...Biochemical, Evolutionary Studies-general, Gastropods -slugs,conch,snails, Metabolism, Metabolism (intracellular), ...**5.0506**

Nitrogen Cycle

NUTRIENT ASSIMILATION RATES - FIELD STUDIES ...Estuaries, Nitrogen, Nutrients, Phosphorus, Tracers-general, ...**5.0990**

TIDE MARSH ECOLOGY AND WILDLIFE ...Management, Microorganisms (non-specific), Nutrients, Phosphorus, Primary Productivity, Swamps-marshes, ...**5.0870**

Nitroso Compounds

DIMETHYLNITROSAMINE IN CURED, SMOKED WHITE FISH AND FLOUR BLEACHED WITH OXIDES OF NITROGEN ...Ethylene, Fish -other, Fish Protein Concentrate, Flour, Nitrous Oxide, ...**6.0007**

Nitrous Oxide

DIMETHYLNITROSAMINE IN CURED, SMOKED WHITE FISH AND FLOUR BLEACHED WITH OXIDES OF NITROGEN ...Ethylene, Fish -other, Fish Protein Concentrate, Flour, Nitroso Compounds, ...**6.0007**

Nomenclature, Classification

THE OSTRACODA OF THE BAY OF NAPLES ...Environmental Ecology, Invertebrate Anatomy, Italy, Life History Studies, Shrimps - Seed Or Mussel, ...**5.0415**

PORCELLANID CRABS OF AUSTRALIA ...Australia, Collections, Crabs, Museum, ...**5.0354**

MONOGRAPH OF THE CEPHALOPODS OF THE NORTH ATLANTIC ...Animal Taxonomy, Atlantic Ocean-north, Depth, Optical, Pubilications -other, Salinity, Temperature, ...**5.0411**

REVISION OF THE CLASSIFICATION AND PHYLOGENY OF THE SUBORDER BALANOMORPHA (CIRRIPEDIA - THORACICA) ...Animal Taxonomy, Barnacles, Collections, Handbooks, Vertical Distribution, ...**5.0704**

FAMILIAL RELATIONSHIPS IN TELEOST FISHES ...Animal Taxonomy, Comparative Anatomy, Fish -other, Genetic, Karyotypes, ...**5.0148**

REVISION OF GENERA AND SUBGENERA OF WATER MITES OF THE WORLD ...Animal Taxonomy, Growth, Moulting & Metamorph, Pubilications -other, Ticks & Mites, World Wide, ...**5.0627**

TAXONOMY AND DISTRIBUTION OF CLUPEOIDS AND REVISION OF THE GENUS ILISHA OF THE FAMILY CLUPEIDAE ...Alewife,menhaden,shad,herring, Animal Taxonomy, Handbooks, Indian Ocean-general, Range Or Territorial Distr. , ...**5.0088**

SYSTEMATICS AND ZOOGEOGRAPHY OF THE BLENNIOID FISHES ...Animal Taxonomy, Bone, Fish -other, World Wide, ...**5.0051**

SYSTEMATIC REVISION OF THE FAMILY PERIPLOMATIDAE ...Animal Taxonomy, Freshwater Mussels, Scallops, ...**5.0401**

COPEPODS PARASITIC ON NEEDLEFISHES ...Aquatic Ecology, Copepods, Ectoparasites, Fish -other, Organic Evolution, ...**5.0389**

THE TAXONOMY AND ZOOGEOGRAPHY OF THE MAGELONIDAE OF THE WORLD ...Animal Taxonomy, Collections, Lugworms, Marine Segmentedworm, World Wide, ...**5.0570**

A SYSTEMATIC REVISION OF THE HOLOTHURIAN FAMILY PSOLIDAE - ECHINODERMATA - HOLOTHUROIDEA ...Animal Taxonomy, Classification - Taxonomy, Comparative Anatomy, Modern Organisms, Sea Cucumber, ...**5.0572**

MARINE POLYCHAETE WORMS OF THE NEW ENGLAND REGION (GULF OF ST. LAWRENCE TO CHESAPEAKE BAY) ...Animal Taxonomy, Lugworms, Marine Segmentedworm, Northeast, Vertical Distribution, ...**5.0574**

AUTOMATIC DATA PROCESSING - SEABIRD DISTRIBUTION ...Birds -non-specific, Computer Methods -general, Range Or Territorial Distr. , World Wide, ...**4.0020**

SYSTEMATICS OF CALIGOID COPEPODS ...Animal Taxonomy, Copepods, Ectoparasites, Host Specificity, ...**5.0392**

SYSTEMATIC REVISION PLATYCEPHALIDAE (PISCES) ...Classical, Fish -other, Indian Ocean-general, Museum, ...**5.0050**

TAXONOMIC STUDIES ...Animal Taxonomy, Fish -other, Pacific Ocean-east, ...**5.0034**

SYSTEMATIC STUDIES ON THE FAMILY SCOMBRIDAE ...Animal Taxonomy, Indian Ocean-general, Tuna, Mackerel, Albacore... , Vertebrate Anatomy, ...**5.0056**

DESCRIPTIONS OF NEW SHARKS ...Animal Taxonomy, Collections, Pubilications -other, Sharks, ...**5.0057**

A REVISION OF THE CAT SHARKS, SCYLIORHINIDAE ...Animal Taxonomy, Sharks, Vertebrate Anatomy, ...**5.0058**

North America

SEDIMENT DISPERSAL PATTERNS IN SUBMARINE CANYONS AND SUBSEA FANS ...Distribution, Fans, Geologic Maps, Submarine Canyons, Textures-structures, ...**7.0215**

North Carolina

PILING PRESERVATIVES THRESHOLD STUDIES ...Biological, Fouling, Massachusetts, Preservatives, Wood, ...**8.0232**

RESEARCH AND TRAINING IN MARINE BIOLOGY ...Marine Biology (non-specific), Training Grants, Fellowships, ...**11.0038**

OPTIMUM ECOLOGICAL DESIGNS FOR ESTUARINE SYSTEMS OF NORTH CAROLINA ...Domestic Wastes-general, Estuaries, Marine Biology (non-specific), Pollution - Effects of , Pollution Effects, Productivity - Food Chain, ...**5.0913**

PHYSICAL AND CHEMICAL PROPERTIES OF THE SHELF AND SLOPE WATERS OFF NORTH CAROLINA ...Atlantic Ocean-north, Continental Shelf, General Sea Water Chemistry, Oceanic Fronts, Water Properties-general, ...**1.0156**

EVALUATION OF HABITAT ALTERATION, CURRITUCK SOUND ...Fish -non-specific, Habitat Studies, Turbidity & Suspended Matter, Water Salinity, ...**5.0914**

PRODUCTIVITY STUDIES IN NORTH CAROLINA SALT MARSHES ...Aerial Photography, Mapping, Primary Productivity, Productivity - Food Chain, Swamps-marshes, Tidewater Areas, ...**5.1017**

CHANGES DURING EUTROPHICATION OF AN ESTUARY ...Estuaries, Eutrophication, Plankton (non-specific), Pollution - Effects of , ...**5.0915**

CURRENT STUDY ON THE NEUSE RIVER AND ESTUARY ...Discharge, Dyes, Estuaries, Tracers, Water Motion, ...**2.0037**

DISTRIBUTION OF LIFE WITH DEPTH ...Continental Shelf, Motion Pictures -non-specific, Photography, Vertical Distribution, ...**5.0885**

PLANKTON ECOLOGY OF BAR-BUILT ESTUARIES ...Estuaries, Phytoplankton, Primary Productivity, Productivity - Food Chain, Zooplankton, ...**5.0816**

COLLECTION AND SURVEY OF NORTH CAROLINA MARINE AND ESTUARINE MOLLUSCA ...Collections, Estuaries, Mollusks -non-specific & Other, Survey Studies, ...**5.0480**

CRUSTACEAN COLLECTION OF EAST COAST OF UNITED STATES ...Atlantic Ocean-north, Collections, Crustacea -non-specific, Estuaries, ...**5.0481**

FISH COLLECTION OF NORTH CAROLINA AND WESTERN ATLANTIC FISHES ...Atlantic Ocean-north, Collections, Fish -non-specific, Fresh Water, ...**5.0133**

ENERGETICS OF PALAEMONETES PUGIO AND THE WEEDBED COMMUNITY OF SOUTH CREEK ESTUARY ...Aquatic Vegetation -ns, Energy Budgets, Estuaries, Habitat Studies, Shrimps - Common, ...**5.0482**

HEAVY MINERAL DISTRIBUTION OF THE WHITE OAK ESTUARY-BOGUE INLET AREA, NORTH CAROLINA ...Bayous, Distribution, Estuaries, Heavy Minerals, ...**7.0269**

A RECONNAISSANCE OF COASTAL EROSION IN NORTH CAROLINA ...Aerial Photography, Beach, Development, Erosional Features, Photogrammetry, Reconnaissance, Shoreline - Coastline, Waves, ...**7.0268**

OCEANOGRAPHY ATLAS OF THE NORTH CAROLINA CONTINENTAL MARGIN ...Atlases-maps, Continental Shelf, Mapping, ...**4.0059**

MARINE MINERAL RESOURCES OF THE NORTH CAROLINA CONTINENTAL MARGIN ...Continental Shelf, Resource Inventories, ...**7.0026**

EVOLUTIONARY DEVELOPMENT OF CUSPATE FORELANDS ...Beach, Continental Shelf, Depositional Features-other, Deposits-other, Development, Shoreline - Coastline, ...**7.0296**

HEAVY METALS AND SEDIMENTATION PROCESS OF THE NORTH CAROLINA SHELF ...Bottom Sampling Device, Continental Shelf, Heavy Minerals, Mineralogy, Sedimentation, ...**7.0021**

OCEAN WATER INTRUSION INTO BACK BAY, VIRGINIA, & CURRITUCK SOUND, NORTH CAROLINA, ON THE WATERFOWL & FRESHWATER FISH HABITAT ...Habitat Studies, Virginia, Water Salinity, Waterfowl -non-specific, ...**5.0897**

North Dakota

MICROPLANKTON OF THE BEARPAW SHALE OF MONTANA AND NORTH DAKOTA ...Cretaceous Period, Fine-grained Clastics, Microfossils, Montana, Planktonic - Floating, ...**7.0249**

North Sea

OCEAN WIND WAVE GENERATION AND DISSIPATION ...Buoys, General Synoptic Observations, Velocity, Waves, Wind-water Interaction, ...**2.0105**

Norwegian Sea

AN INVESTIGATION OF THE OVERFLOW OF NORWEGIAN SEA WATER INTO THE NORTH ATLANTIC THROUGH DENMARK STRAIT ...Atlantic Ocean-north, Ocean Currents-other, Oceanic Fronts, ...**2.0032**

Nucleic Acids -non-specific

GEOCHEMISTRY OF NUCLEIC ACIDS ...Biochemical, Biogeochemical Process, Chemistry, Exobiology, Organic, ...**7.0054**

Nucleotides -non-specific

PROCESS-INDUCED CHANGES IN CRUSTACEAN MUSCLE TISSUE ...Crabs, Heat, Organoleptic Studies, ...**5.0350**

Numerical Analysis

Computers

Research - Development

GRAVITY AND MAGNETIC DATA COLLECTED DURING THE INTERNATIONAL INDIAN OCEAN EXPEDITION AND IN THE CARIBBEAN SEA ...Data Analysis - General, Data Reduction and Analysis, Digital Computer Applications, Gravity Studies, Indian Ocean-general, Magnetic Studies, ...**4.0030**

DIGITAL RECORDING AND PROCESSING OF IN SITU DEPTH-TEMPERATURE-SALINITY DATA ...Bathythermographs, Depth, Error Analysis, Salinity, Temperature, ...**4.0025**

FOSDIC APPLICATION TO CURRENT-METER RECORDS ...Currents-ocean, Data & Statistics Storage, Recording Systems, Technique Development, Water Motion Recorders, ...**4.0021**

OBJECTIVE WEATHER ANALYSIS ...Technique Development, Tropic, Weather Forecasting, Wind-general, ...**4.0042**

Simulation

GALVESTON BAY STUDY ...Estuaries, Numerical Analysis-other, Optimization, Tides, Waste Water Treatment-general, ...**4.0062**

Numerical Analysis-other

CLIMATE CHANGE OVER THE POLAR OCEAN ...Arctic Ocean, Heat and Radiation Transfer, Heat Budget, Physical Climatology, ...**3.0058**

DETERMINATION OF TIDES IN THE REAL OCEANS ...Forecasting-prediction, Partial, Tides, ...**2.0089**

GALVESTON BAY STUDY ...Estuaries, Optimization, Simulation, Tides, Waste Water Treatment-general, ...**4.0062**

NUMERICAL WAVE PREDICTION ...Development of Models, Forecasting-prediction, Model Studies, Waves, ...**2.0104**

Numerical Methods

Algorithms

OPTIMIZATION METHODS APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL AUXILIARY ...Cost Analysis, Engineering Studies-other, Optimization Technique, Other-design-and-construction, Requirement, ...**8.0297**

OPTIMIZATION METHOD APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL SALVAGE TUG ...Design of Experiments, Operational Aspect, Optimization Technique, Other-design-and-construction, Random Variables, ...**8.0307**

ADVANCED MARINE TRANSPORTATION SYSTEM/ANALYSIS MODEL ...Consumption, Cost Analysis, Input - Output Analysis, Merchant-ships, Models, Systems Analysis, ...**4.0068**

Approximations

EXPLOSIVE WAVE PROPAGATION ...Explosives, Integral Equations, P-waves, Propagation, Travel Time, ...**7.0126**

PARTIAL DIFFERENTIAL EQUATIONS AND CONTINUUM MECHANICS ...Acoustical, Ordinary, Partial, Waves, ...**8.0171**

WEIGHT ANALYSIS IN FISHING BOATS ...Hull, Low Alloy Steels, Measuring Devices-other, Pressure Effects, ...**8.0295**

Error Analysis

ERROR ANALYSIS OF SEVERAL BOTTOM REFERENCED NAVIGATION SYSTEMS FOR SMALL SUBMERSIBLES ...Navigation, Operational Aspect, Sonar, Submersibles, Subsurface Environments, Systems Analysis, ...**4.0111**

DIGITAL RECORDING AND PROCESSING OF IN SITU DEPTH-TEMPERATURE-SALINITY DATA ...Bathythermographs, Depth, Research - Development, Salinity, Temperature, ...**4.0025**

Finite Differences

BOTTOM CURRENTS AND DEEP SEA TIDES ...Abyssal, Acoustical, Benthonic-bottom, Currents-other, Model Studies, Tides, ...**2.0004**

FINITE ELEMENT TECHNIQUES ...Distribution, Mathematical Analysis, Mechanical Properties, Model Studies, Rock Mechanics, ...**8.0254**

Optimization Technique

OPTIMIZATION METHODS APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL AUXILIARY ...Algorithms, Cost Analysis, Engineering Studies-other, Other-design-and-construction, Requirement, ...**8.0297**

OPTIMIZATION METHOD APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL SALVAGE TUG ...Algorithms, Design of Experiments, Operational Aspect, Other-design-and-construction, Random Variables, ...**8.0307**

Simulation Theory

DEVELOPMENT OF PHYSICAL-NUMERICAL MODELS FOR STUDIES OF THE ATMOSPHERE-OCEAN PLANETARY BOUNDARY LAYER ...Advection, Mixing, Thermal, Turbulence, Wind-water Interaction, ...**3.0010**

SIMULATION MODEL FOR THE ANALYSIS OF ADVANCED MARINE SHIPPING SYSTEMS ...Transportation Systems, Water Transportation, ...**4.0063**

EXPERIMENTAL HYDRODYNAMICS ...Fluid Dynamics, Heat and Radiation Transfer, Hydrodynamics, Submersibles, Thermocline, ...**8.0192**

FIORD OCEANOGRAPHY ...Alaska, Estuaries, Fjords, Hydrodynamics, Model Studies, ...**4.0040**

RESIDENCE TIMES OF WATERS BEHIND BARRIER ISLANDS ...Bays, Circulation-general, Tides, Wind-water Interaction, ...**2.0018**

INVESTIGATION OF THE NON-LINEAR CHARACTERISTICS OF FLUID-SUSPENDED VEHICLES ...Dimensionless-parameters-other, Hydrofoils Crafts, Non Linear, Non-linear, Stability, ...**8.0184**

HURRICANES AND OTHER TROPICAL METEOROLOGICAL PROBLEMS ...Meteorologic Model Studies, Storms, Tropical Cyclones, Weather Forecasting, ...**3.0046**

Nutrition - Medical

Analysis of Foods

PREPARATION OF FISH PROTEIN HYDROLYSATES ...Chemical Analysis, Fish -non-specific, Fish Protein Concentrate, Heat, Protein, ...**6.0066**

Diet Components - Role

Amino Acids

BIOCHEMISTRY OF FISH AS RELATED TO HUMAN NUTRITION ...Hypoxanthine, Northeast, ...**6.0053**

Proteins

ANTIOXIDANT AND NUTRITIONAL POTENTIAL OF FERMENTED AND UNFERMENTED SOYBEANS IN COMBINATION WITH FISH ...Fermentation, Malting, Fish -non-specific, Food Spoilage Detection, Rancidity, Soybeans, ...**6.0023**

UTILIZATION OF LATENT MARINE RESOURCES AND WASTE PRODUCTS ...Fish -other, Fish Meals, Fish Protein Concentrate, Proteins and Amino Acids, Salmon & Trout - Non-specific, ...**6.0068**

UTILIZATION AND PREPARATION OF FISH PROTEIN CONCENTRATE ...Chemical Analysis, Fish & Shellfish, Fish Protein Concentrate, Nutritive Value, Organoleptic Studies, ...**6.0125**

Toxicological and Allergy

EFFECTS OF INGESTION OF RADIOACTIVE FISH AND THE NATURE AND BIOLOGY OF TOXINS IN CERTAIN FISHES ...Fish -non-specific, Food (epidemiology), Food Chains, Radioactive Isotopes, ...**6.0108**

APPLICATION OF RADIATION PASTEURIZATION PROCESSES TO PACIFIC CRAB AND FLOUNDER ...Clostridium Botulinum, Fish -non-specific, Microbiological, Processing, Radiation, ...**6.0083**

EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC ...Animal Toxins, Marine Biology (non-specific), Pacific Ocean-general, Toxic Substances -non-specific, ...**6.0109**

EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC ...Animal Toxins, Pacific Ocean-general, Toxicology, ...**6.0110**

STUDY OF THIAMINASE IN HAWAII FISH ...Enzymatic, Enzyme Inhibitors, Fish -non-specific, Hawaii, Thiaminase, ...**5.0260**

EFFECTS OF HANDLING AND PROCESSING PROCEDURES IN POTENTIAL PATHOGENUS ON FISH ...Clostridium Botulinum, Fish -other, Legal Standards, Microbiological, Smoking, ...**6.0044**

TOXIC IMPURITIES IN MARINE PROTEIN CONCENTRATE ...Fish Protein Concentrate, Food Spoilage -other, Infection, Intoxication & Pois, Toxic Substances -non-specific, ...**6.0009**

PROGRAM PROJECT - FOOD MICROBIOLOGY ...Clostridia (non-specific & Ot), Food (epidemiology), Infection, Intoxication & Pois, Microbiological, Salmonella (non-specific & Ot), ...**6.0005**

STUDIES ON VIBRIO FOOD POISONING ...Bacteria, Bacterial Endotoxins, Food (epidemiology), Microbiological, Vasomotor, ...**6.0114**

ORGANISMS RESPONSIBLE FOR TOXICITY OF ALASKAN CLAMS ...Alaska, Biological Pollutants -general, [illegible], Food Spoilage Detection, Microbiological, Pollutants-general, ...**5.0344**

Occupations, Populations

Military Personnel

Naval Personnel

SUBMARINE MEDICINE ...Life-support-system, Occupational Hazards, Ordnance, Safety, ...**8.0018**

Occupations - Other Specific

Divers

MAN IN THE SEA - VISUAL ACUITY RESEARCH ...Acuity, Diving and Scuba, Experiments and Tests, Optical, Submersibles, ...**6.0089**

MANNED DIVING RESEARCH ...Decompression Sickness, Diving and Scuba, Liquid-breathing, Medical Studies, ...**6.0096**

HUMAN PERFORMANCE ...Diving and Scuba, Medical Studies, Pressure, ...**6.0097**

LIFE SUPPORT RESEARCH ...Diving and Scuba, Medical Studies, Subsurface Environments, Technique Development, ...**8.0027**

DECOMPRESSION TABLE DEVELOPMENT ...Decompression Sickness, Digital Computer Applications, Diving and Scuba, Mathematical Biophysic, Medical Studies, Tables, Compilations, Catalogs, ...**6.0098**

HUMAN PERFORMANCE IN UNUSUAL ENVIRONMENTS ...Diving and Scuba, Facilities, Medical Studies, Pressure, ...**12.0005**

DIVING MEDICINE ...Diffusion of Gases, Diving and Scuba, Occupational Hazards, Pressure, ...**8.0017**

DEEP DIVING DECOMPRESSION EQUIPMENT AND TECHNIQUES ...Decompression Sickness, Diving and Scuba, Medical Studies, Navigation Communication, Safety, ...**8.0022**

SEALAB III PARTICIPATION ...Behavioral Ecology, Bioluminescence, Diving and Scuba, Medical Studies, Submersibles, ...**6.0091**

Ocean History

TIME DEPENDENT VARIATIONS IN SURFACE OCEANIC CIRCULATION ...Circulation-general, Pollution Sources-general, Sedimentary History, Temperature, Waste Disposal-general, ...**2.0038**

THE POSTPLEISTOCENE OCEANOGRAPHY AND BIOLOGY OF THE EASTERN NORTH PACIFIC ...Climatography, Marine Biology, Pacific Ocean-east, Pacific Ocean-north, ...**7.0158**

SEDIMENTATION, MORPHOLOGY, AND STRUCTURE--MID-ATLANTIC RIDGE ...Atlantic Ocean-general, Distribution, Provenance Studies-other, Ridges, Sea Floor Spreading, ...**7.0047**

MASS SPECTROMETRIC AND MANOMETRIC STUDIES OF THE OCEANS AND THE ATMOSPHERE ...Chemical Analysis (water), Gases, Mass Spectroscopy, Particle-gas Transfer, Solubility, ...**1.0101**

A STUDY OF THE STRUCTURAL RELATIONS BETWEEN THE MID-PACIFIC OCEANIC RIDGES AND FRACTURE ZONES ...Anomalies, Polynesia, Ridges, Structural Studies, Tectogenesis, ...**7.0111**

A SEDIMENTOLOGIC STUDY OF MOBILE BAY AND PERDIDO BAY ...Alabama, Bays, Distribution, Rate of Deposition, Stratigraphy-general, ...**7.0231**

BIOSTRATIGRAPHY OF MID-ATLANTIC RIDGE SEDIMENTS ...Biofacies, Biogenous, Correlation, Order Foraminifera, Ridges, ...**7.0209**

RESOURCES OF THE BERING CONTINENTAL MARGIN ...Bering Sea, Continental Shelf, Dimensions-distribution, Geology-general, Ocean Mining, ...**7.0016**

Ocean Mining

APPLICATION OF NUCLEAR TECHNIQUES TO MARINE MINERALS TECHNOLOGY ...Activation Analysis, Geological Exploration, Gold, Manganese, Physical Properties, ...**8.0085**

AN APPROACH TO MARINE RESOURCE DEVELOPMENT IN ALASKA ...Alaska, Marine Biology (non-specific), Planning, ...**7.0001**

THE ECONOMIC POTENTIAL OF THE MINERAL AND BOTANICAL RESOURCES OF THE U.S. CONTINENTAL SHELF AND SLOPE ...Ag Uses of Nat. resource-other, Continental Shelf, Continental Slope, Estimates of Reserves, Potential of Deposit, ...**7.0011**

SYMPOSIUM ON THE MINERAL RESOURCES OF THE WORLD OCEAN ...Engineering Studies-general, Meetings, Policy Making, Rhode Island, ...**7.0027**

FORMATION AND DEGRADATION OF MANGANESE NODULES BY MARINE BACTERIA ...Cobalt, Manganese, Marine Bacteria, Nickel, Titanium, ...**7.0025**

MARINE GEOLOGY OF THE CALIFRONIA CONTINENTAL BORDERLAND WITH EMPHASIS ON FUTURE ECONOMIC DEVELOPMENT AND GENERAL RESOURCE VALUE ...California, Clay Minerals-general, Continental Shelf, Heavy Elements, Mineralogy, ...**7.0010**

AN ANALYSIS OF THE LAW OF THE CONTINENTAL SHELF AND OF THE RESOURCES OF THE DEEP SEA FLOOR ...Continental Shelves, International, Legal Review, Legal Studies-general, Water Rights, ...**10.0003**

PACIFIC SALMON FISHERIES - ECONOMICS OF MANAGEMENT ...Appraisals-general, Continental Shelf, International, Legal Review, Legal Studies-general, Science & Technology, ...**10.0006**

DEEP SEA MINING PROJECT ...Dredging, Equipment, Scientific-service-support, Technique Development, ...**8.0259**

SEAMOUNT INVESTIGATION ...Anomalies, Data Analysis - General, Geothermal, Magnetic Studies, Seamounts-guyots, Sonar, ...**7.0107**

DEVELOPMENT OF OFFSHORE SOURCES OF SAND SUITABLE FOR BEACH RESTORATION AND NOURISHMENT ...Beach, Coring and Dredging, Mapping, Shoreline Structures, Size, ...**7.0012**

DISTRIBUTION OF HEAVY METALS, WESTERN GULF OF MEXICO ...Chemistry, Dimensions-distribution, Geophysics-general, Gulf of Mexico, Heavy Minerals, ...**7.0013**

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MISSISSIPPI DELTA ...Deltas, Distribution, Heavy Minerals, Mississippi, Potential of Deposit, Sedimentary History, ...**7.0014**

MARINE GEOLOGY STUDIES, GULF OF MEXICO-CARIBBEAN REGION ...Dimensions-distribution, Distribution, Geology-general, Gulf of Mexico, Tectonics-general, ...**7.0103**

OREGON-CALIFORNIA BLACK SANDS ...Beaches, California, Heavy Mineral Analysis, Heavy Minerals, Mineralogy, Potential of Deposit, ...**7.0015**

RESOURCES OF THE BERING CONTINENTAL MARGIN ...Bering Sea, Continental Shelf, Dimensions-distribution, Geology-general, Ocean History, ...**7.0016**

ANALYSIS AND INTERPRETATION OF DATA FROM GEOPHYSICAL AND PHOTOGRAB SURVEY OF CORONADO BANK, OFF SOUTHERN CALIFORNIA ...California, Phosphate, Photography, Potential of Deposit, ...**7.0004**

MARINE HEAVY-METALS PRODUCTION INFORMATION, ON WORLDWIDE BASIS ...Appraisals-general, Beneficiation, Deposits-ores, Documents & Literature, Heavy Elements, ...**7.0006**

FEASIBILITY STUDY OF THE USE OF ELECTRICAL METHODS FOR DETERMINING SIZE AND SHAPE OF DEPOSITS ...Dimensions-distribution, Electric Logging, Instrumental Services, Methodology, Technique Development, ...**7.0008**

LABORATORY MODEL STUDIES OF COMPARTIVE METHODS OF PENETRATION OF DETRITUS ...Disturbed/undisturbed, Mechanical Properties, Rock Fragmentation Methods, Sand, Soil Sampling, ...**8.0257**

BACKGROUND AND EXPLORATORY STUDIES OF MATERIALS HANDLING IN THE MARINE ENVIRONMENT ...Equipment, Freight, Pipelines, Rock Fragmentation Methods, Scientific-service-support, ...**8.0258**

HISTORICAL STUDY ON EFFECT OF HARBOR DREDGING ON THE ENVIRONMENT (ENVIRONMENTAL FACTORS PERTINENT TO EFFECTS ON MARINE ENVIRONMENTS) ...Dredging, Environmental Effects-geologic, Excavation, Harbors, Marine Environments-general, ...**6.0135**

ENGINEERING EVALUATION OF EXISTING DREDGE SYSTEMS AND OPERATIONS ...Dredging, Excavation, ...**8.0246**

ANALYSIS OF THE EFFECT ON OPERATING COSTS AND RETURN ON INVESTMENT OF VARIATIONS IN OPERATING PARAMETERS ...Cost Analysis, Costs, Economics, Systems Analysis, ...**4.0174**

FEASIBILITY STUDY ON HORIZONTAL TEST TANK FOR MODEL STUDIES AND COMPONENT TESTING ...Consultants, Advisory Services, Dredging, Equipment, Model Studies, Tanks, ...**12.0007**

ACOUSTIC HOLOGRAPHY ...Acoustical, Diffraction, Holography, Liquids, ...**8.0255**

Mine Engineering

Equipment

DEEP SEA MINING PROJECT ...Dredging, Ocean Mining, Scientific-service-support, Technique Development, ...**8.0259**

BACKGROUND AND EXPLORATORY STUDIES OF MATERIALS HANDLING IN THE MARINE ENVIRONMENT ...Freight, Ocean Mining, Pipelines, Rock Fragmentation Methods, Scientific-service-support, ...**8.0258**

Mine Types

Placer

MARINE-FLUVIAL INTERFACE, COASTAL OREGON ...Development, Heavy Minerals, Oregon, Processes, Shoreline - Coastline, Terrace-bench, ...**7.0018**

GEOLOGICAL, GEOPHYSICAL, OCEANOGRAPHIC, AND ECOLOGICAL DATA ON WORLDWIDE BASIS, ON AREAS OF HEAVY METALS POTENTIAL ...California, Continental Shelf, Drilling and Coring, Oregon, Potential of Deposit, ...**7.0005**

TESTING AND EVALUATION OF MAGNETOMETER/GRADIOMETER AND TOW VEHICLE SYSTEM ...Evaluation Other, Field Testing, Instrumental Services, Magnetic Studies, Ore Deposits, ...**8.0116**

OREGON-NORTHERN CALIFORNIA PLACER DEPOSITS ...California, Deposits-ores, Drilling and Coring, Oregon, Reconnaissance, ...**7.0009**

LABORATORY MODEL STUDIES ON PRESSURE DISTRIBUTION IN DETRITUS DURING PENETRATION ...Laboratory Analysis, Mechanical Properties, Model Studies, Pressure, Soil Loads, ...**8.0253**

LABORATORY STUDIES TO CORRELATE ENGINEERING PROPERTIES OF MARINE PLACER MATERIALS WITH SAMPLING TOOL PERFORMANCE ...Coring and Dredging, Gold, Laboratory Analysis, Mechanical Properties, Scientific-service-support, ...**8.0244**

Mine Wastes

A STUDY OF THE LEAD OXYCHLORIDES AND RELATED SPECIES FOUND IN THE ANCIENT SLAGS OF LAURIUM, GREECE ...Chemical Reactions, Discriptions of Minerals, Greece, Mineral Genesis, Silver, ...**7.0058**

PUERTO RICO COOP - MONA PASSAGE ...Continental Shelves, Land Economics, Oil - Petroleum, Potential of Deposit, Puerto Rico, Sands and Gravels, ...**7.0034**

Mining Methods

Dredging

DEEP SEA MINING PROJECT ...Equipment, Ocean Mining, Scientific-service-support, Technique Development, ...**8.0259**

HISTORICAL STUDY ON EFFECT OF HARBOR DREDGING ON THE ENVIRONMENT (ENVIRONMENTAL FACTORS PERTINENT TO EFFECTS ON MARINE ENVIRONMENTS) ...Environmental Effects-geologic, Excavation, Harbors, Marine Environments-general, Ocean Mining, ...**6.0135**

ENGINEERING EVALUATION OF EXISTING DREDGE SYSTEMS AND OPERATIONS ...Excavation, Ocean Mining, ...**8.0246**

FEASIBILITY STUDY ON HORIZONTAL TEST TANK FOR MODEL STUDIES AND COMPONENT TESTING ...Consultants, Advisory Services, Equipment, Model Studies, Ocean Mining, Tanks, ...**12.0007**

Rock Fragmentation Methods

LABORATORY MODEL STUDIES OF COMPARTIVE METHODS OF PENETRATION OF DETRITUS ...Disturbed/undisturbed, Mechanical Properties, Ocean Mining, Sand, Soil Sampling, ...**8.0257**

BACKGROUND AND EXPLORATORY STUDIES OF MATERIALS HANDLING IN THE MARINE ENVIRONMENT ...Equipment, Freight, Ocean Mining, Pipelines, Scientific-service-support, ...**8.0258**

Ocean Sediments

Biogenous

BIOGEOCHEMISTRY OF TERRESTRIAL & EXTRATERRESTRIAL ORGANIC MATTER ...Biochemical, Biogeochemical Process, Diagenesis, Exobiology, Organic, Sulfur Bacteria, ...**7.0074**

THE CYCLE OF ORGANIC MATTER IN THE DEEP SEA ...Abyssal, Adsorption, Distribution, Marine Bacteria, Origin, ...**1.0112**

RADIOLARIA IN SEDIMENTS ...Core Analysis, Order Radiolaria, Pacific Ocean-general, Population - Distribution, Tertiary Period, ...**7.0160**

STUDY OF RADIOLARIA IN SURFACE SEDIMENTS OF THE NORTHEAST PACIFIC OCEAN ...Animal Taxonomy, Pacific Ocean-north, Protozoa -other, Vertical Distribution, ...**7.0187**

GEOCHEMICAL STUDIES OF DEEP-SEA DEPOSITS - THEIR SOURCES AND MODES OF DEPOSITION ...Abyssal, Atlantic Ocean-general, Biogeochemical Process, Chemistry, Mineralogy, Ocean Bottom, ...**7.0057**

RADIOLARIA IN PACIFIC SEDIMENTS ...Arctic, Classification - Taxonomy, Order Radiolaria, Pacific Ocean-north, Population - Distribution, ...**7.0284**

CALCAREOUS NANNOFOSSILS FROM PALEOCENE - EOCENE DEPOSITS ...Fossil Limestone, Fossil Zones, Microfossils, Standards, Specifications, Tertiary Period, ...**7.0176**

TAXONOMY AND STRATIGRAPHY OF CALCAREOUS NANNOPLANKTON IN MARINE SEDIMENT SEQUENCES ...Classification - Taxonomy, Correlation, Fossil Limestone, Microfossils, Order Foraminifera, Paleontology, ...**7.0168**

DEEP SEA SEDIMENTS IN THE NORTH PACIFIC FROM STUDIES OF THEIR RADIOLARIAN CONTENT ...Core Analysis, Distribution, Pacific Ocean-north, Protozoa -other, Sedimentation, ...**7.0285**

SEA-FLOOR SEDIMENTS AND ROCK STUDIES ...Atlantic Ocean-north, Core Analysis, Microfossils, Paleomagnetism, Petrology, Ridges, Sedimentation, ...**7.0040**

BIOSTRATIGRAPHY OF MID-ATLANTIC RIDGE SEDIMENTS ...Biofacies, Correlation, Ocean History, Order Foraminifera, Ridges, ...7.0209

OSTRACODA OF THE INDIAN OCEAN ...Animal Taxonomy, Indian Ocean-general, Quaternary Period, Shrimps - Seed Or Mussel, ...5.0385

Biology

MARINE SEDIMENTS ...Chemistry, Core Analysis, Physical Properties, Subbottom, Textures-structures, ...7.0264

LIVING AND FOSSIL ZOOPLANKTON, AND RELATED PROBLEMS OF PALEOLIMNOLOGY ...Aquatic Ecology, Ecological, Microfossils, Paleoecology, Zooplankton, ...7.0171

ENVIRONMENTAL SIGNIFICANCE OF SABELLARIID REEFS ...Habitat Studies, Lugworms, Marine Segmentedworm, Reefs, ...5.0592

TROPHIC RELATIONSHIPS IN SHOAL BENTHIC ENVIRONMENTS ...Benthic Flora, Estuaries, Habitat Studies, New England Province, ...5.1027

DEEP WATER BENTHIC POLYCHAETES ...Benthic Fauna, Lugworms, Marine Segmentedworm, Photography, Vertical Distribution, ...5.0540

THE EFFECTS OF SEAL AND FISH PREDATION ON CERTAIN ANTARCTIC BENTHIC COMMUNITIES ...Antarctica, Benthic Organisms (non-specif), Fish -non-specific, Predation, Productivity - Food Chain, Seals, ...5.1039

ORGANIC INFLUENCES ON CALCIUM CARBONATE CEMENTATION ...Algae- General, Algal Culture, Cement Origin, Marine Plants, Secretions and Products, ...5.0729

DEEP SEA BENTHOS IN THE GULF OF MEXICO ...Benthic Fauna, Benthonic-bottom, Gulf of Mexico, Population Dynamics, ...5.0655

EXPERIMENTAL CULTURE OF CALCAREOUS GREEN ALGAE OF CORAL REEFS ...Algal Culture, Calcium, Chlorophyceae (non-specif.&ot), Growth and Differentiation, Plant Taxonomy, Reefs, ...5.0719

BOTTOM ENVIRONMENT--GULF OF MEXICO ...Benthonic-bottom, Chemistry, Gulf of Mexico, Ocean Currents-other, Physical Properties, ...2.0043

FEASIBILITY OF THE APPLICATION OF PALYNOLOGICAL INVESTIGATION OF DEEP-SEA SEDIMENTS TO MAJOR GEOLOGICAL PROBLEMS ...Circulation-general, Paleoclimatology, Pollen, Pollens, Spores, ...7.0206

PHYSIOLOGICAL CHARACTERIZATION OF CERTAIN MARINE BACTERIA ...Bact. morphology (general), Bacterial Culture, Isolation From Nat. environ. , Marine Bacteria, Metabolism (intracellular), Tissue Techniques, ...5.0784

BIOLOGICAL OCEANOGRAPHY & DETERIORATION - SHALLOW WATER MARINE SEDIMENTS & WATER COLUMN BACTERIA ...Continental Shelf, Instrumentation-general, Marine Bacteria, Nephelometry, Vertical Distribution, ...5.0807

BIOLOGICAL OCEANOGRAPHY AND DETERIORATION, DEEP OCEAN-HIGH PRESSURE BACTERIA ...Biological, Chemistry, Identification, Microorganisms (non-specific), Submersibles, ...8.0236

GEOLOGICAL OCEANOGRAPHY - PHYSICAL PROPERTIES ...Bearing Capacity, Chemistry, Photography, Physical Properties, Shear Strength, ...8.0337

RECONNAISSANCE ECOLOGIC SURVEY OF THE CONTINENTAL SHELF AND UPPER SLOPE (GULF OCEANOGRAPHY PROGRAM) ...Behavioral Ecology, Continental Shelf, Environmental Ecology, Migration, Population Dynamics, Shrimps - Common, ...5.0502

Chemistry

ANALYSIS OF PHYSICAL AND CHEMICAL PROPERTIES OF DEEP SEA CORES ...Coring and Dredging, Physical Properties, ...7.0259

GEOCHEMISTRY OF NUCLEIC ACIDS ...Biochemical, Biogeochemical Process, Exobiology, Nucleic Acids -non-specific, Organic, ...7.0054

INVESTIGATIONS OF URANIUM AND THORIUM SERIES ISOTOPE DISEQUILIBRIUM IN THE OCEAN AND IN PLEISTOCENE SEDIMENTS ...Glacial History, Quaternary Period, Radioactivity, Radium, Thorium, Uranium, ...1.0120

BIOLOGICAL FRACTIONATION OF STABLE ISOTOPES ...Inorganic, Microbiological Analysis, Trace Elements, ...7.0052

URANIUM GEOCHEMISTRY IN (MODERN) CARBONATES USING THE FISSION TRACK METHOD ...Biogeochemical Process, Carbonates-general, Diagenesis, Organism Sampling Devices, Uranium, ...7.0076

RADIOELEMENT STUDIES IN THE OCEANS - GEOLOGY AND GEOCHEMISTRY ABOUT THE MID-ATLANTIC RIDGE ...Adsorption Capacity, Isotope, Removal--inorganics, Ridges, Water Analysis, ...7.0072

NUCLEAR CHEMISTRY AND GEOCHEMISTRY RESEARCH ...Iron, Nuclear - General, ...7.0082

MARINE SEDIMENTS ...Biology, Core Analysis, Physical Properties, Subbottom, Textures-structures, ...7.0264

ALTERATION OF MINERALS ...Aragonite, Mineralogy, Saline Water Systems, Silicates, Solution Chemistry, ...7.0056

ECOLOGY AND SEDIMENTARY PATTERNS OF FORAMINIFERA ...Environmental Ecology, Environmental Effects-geologic, Foraminifera, Vertical Distribution, ...5.0746

MEASUREMENTS OF OXYGEN CONSUMPTION BY THE SEA BED IN DEEP WATER OF PUGET SOUND ...Benthic Flora, Oxygen, Oxygen Content -water, Puget Sound, ...5.1036

CARBON ISOTOPE GEOTHERMOMETRY ...Carbon, Carbonaceous Substance, Core Analysis, Geologic Thermometry, Paleotemperature, Plankton (non-specific), Temperature, ...7.0079

THE MARINE GEOLOGY OF THE SOUTHERN OCEAN ...Antarctic Ocean, Coring and Dredging, Distribution, Mineralogy, Petrology, ...7.0067

RARE GAS STUDY OF INTERPLANETARY MATERIAL IN PELAGIC SEDIMENTS ...Cosmogenous, Element Ratios, Equipment Purchase Operation, Mass Spectroscopy, Mineralogy, X-ray, ...7.0081

STRUCTURE, MINERALOGY, AND CHEMICAL COMPOSITION OF MARINE MANGANESE NODULES ...Manganese, Mineralogy, Origin, Polished Sections, Precipitates, Textures-structures, ...7.0028

THE GEOCHEMISTRY, MINERALOGY AND ORIGIN OF PELAGIC SEDIMENTS IN AREAS OF HIGH HEAT FLOW AND FRACTURE ZONES ...Diagenesis, Geochemistry, Heat Flow Measurements, Mineralogy, Origin, Sedimentation, ...7.0227

GEOCHEMICAL STUDIES OF DEEP-SEA DEPOSITS - THEIR SOURCES AND MODES OF DEPOSITION ...Abyssal, Atlantic Ocean-general, Biogenous, Biogeochemical Process, Mineralogy, Ocean Bottom, ...7.0057

GEOCHEMISTRY OF MID-ATLANTIC RIDGE SEDIMENTS ...Atlantic Ocean-general, Core Analysis, Correlation, Geochronology-general, Ridges, ...7.0071

HEAVY METAL GEOCHEMISTRY OF ANTARCTIC SEA WATER AND MARINE SEDIMENTS ...Antarctic Ocean, Circulation-general, Sedimentation, Water Analysis-general, ...1.0086

SOLUTION-SILICATE REACTIONS AND EQUILIBRIA ...Chemical Reactions, Equilibrium - Chemical, Groundwater, Reaction-general, Silicate-general, Solution, Solution Chemistry, ...1.0097

STUDIES OF OXYGEN-FREE, SULFIDE-BEARING MARINE ENVIRONMENTS ...Model Studies, Organics, ...1.0135

MINERALOGICAL STUDIES OF PARTICULATE MATTER SUSPENDED IN SEA WATER ...Mineralogy, Suspension, Water Chemistry-other, ...1.0122

BOTTOM ENVIRONMENT--GULF OF MEXICO ...Benthonic-bottom, Biology, Gulf of Mexico, Ocean Currents-other, Physical Properties, ...2.0043

STUDIES IN MARINE CHEMISTRY ...Bone, Trace Elements, ...7.0068

ENVIRONMENT OF DEPOSITION OF ARGILLACEOUS SEDIMENTS ...Adsorption Capacity, Boron, Clays, Deltas, Mississippi River, ...7.0240

BIOLOGICAL OCEANOGRAPHY AND DETERIORATION, DEEP OCEAN-HIGH PRESSURE BACTERIA ...Biological, Biology, Identification, Microorganisms (non-specific), Submersibles, ...8.0236

GEOLOGICAL OCEANOGRAPHY - PHYSICAL PROPERTIES ...Bearing Capacity, Biology, Photography, Physical Properties, Shear Strength, ...8.0337

MARINE HYDROLOGY AND GEOCHEMISTRY, ATLANTIC CONTINENTAL SHELF AND SLOPE ...Atlantic Ocean-north, Continental Shelf, Continental Slope, Saline Water Intrusion, Sedimentation, ...7.0070

DISTRIBUTION OF HEAVY METALS, WESTERN GULF OF MEXICO ...Dimensions-distribution, Geophysics-general, Gulf of Mexico, Heavy Minerals, Ocean Mining, ...7.0013

CLAY CHEMISTRY ...Chemical, Size, Terrigenous. ...7.0063

EAST COAST CONTINENTAL MARGIN WOODS HOLE OCEANOGRAPHIC INSTITUTE CONTRACT ...Continental Shelf, Estuaries, Interstitial - Connate Water, Maine, ...4.0119

SAMPLING CAMPAIGN ON CORONADO BANK, OFF SOUTHERN CALIFORNIA ...Banks, California, Coring and Dredging, Distribution, Phosphate, Phosphite, ...7.0003

SEDIMENT MINERALOGY (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Adsorption, Food Webs, Productivity - Food Chain, Radioactivity, Radioactivity-general, ...7.0077

Cosmogenous

NEUTRON ACTIVATION ANALYSIS OF IRON METEORITES ...Activation Analysis, Aluminum, Argon-potassium, Carbon, Iron, Neutron Activation, ...7.0065

ELECTRON MICROSCOPE AND ELECTRON DIFFRACTION STUDIES OF GEOLOGICAL SAMPLES ...Electron, Electron Microscopy, ...7.0278

RARE GAS STUDY OF INTERPLANETARY MATERIAL IN PELAGIC SEDIMENTS ...Chemistry, Element Ratios, Equipment Purchase Operation, Mass Spectroscopy, Mineralogy, X-ray, ...7.0081

CHRONOLOGY OF MARINE SEDIMENTS, CIRCULATION OF WATER AND TRACE ELEMENTS, SEDIMENTARY RECORD AND EXTRATERRESTRIAL ACCRETION ...Circulation-general, Pacific Ocean-general, Paleoclimatology, Sedimentary History, Trace Elements, ...1.0098

Distribution

SUBMARINE GEOLOGY OF GASTINEAU CHANNEL JUNEAU, ALASKA ...Alaska, Basins, Seismic Studies, Size, Subbottom, ...7.0191

THE GEOCHEMISTRY OF RADIOACTIVE ELEMENTS IN THE MARINE ENVIRONMENT - THE GEOCHEMISTRY OF LANDLOCKED SEAS ...Element Ratios, Oceans - Sea Water, Radioactive Dating, Sedimentation, Uranium, ...1.0095

DEPOSITION RATES BY THE PROTACTINIUM METHOD ...Chemical, Element Ratios, Manganese, Sedimentary Petrogenesis, Thermal, Thorium, Uranium, ...7.0270

THE CYCLE OF ORGANIC MATTER IN THE DEEP SEA ...Abyssal, Adsorption, Biogenous, Marine Bacteria, Origin, ...1.0112

RADIOISOTOPIC TRACER STUDY TO INVESTIGATE THE MECHANICS OF LITTORAL TRANSPORT AROUND POINT CONCEPTION, CALIFORNIA ...Continental Shelf, Ocean Waves - Currents, Sediment Transport-other, Tracers, Xenon, ...7.0216

MARINE SEISMOLOGY ...Crust, Earth Interior, Seismic Reflection, Seismic Refraction, Textures-structures, ...7.0131

MARINE GEOLOGY ...California, Continental Shelf, Ocean Waves - Currents, Sedimentation, Submarine Canyons, ...7.0260

SEDIMENT STRUCTURE ...Coral Sea, Geosynclines, Sediment Transport-general, Shelf Areas, Textures-structures, ...7.0204

SAND RIPPLES ...Beaches, Grain Size, Ocean Waves - Currents, Ripple Marks, Shape, ...7.0196

SUPPORT OF UNIVERSITY OF GEORGIA MARINE INSTITUTE RESEARCH VESSEL OPERATION ...Continental Shelf, Continental Slope, Environmental Ecology, Estuaries, Geomorphology-topography, Marine Biology, Pollution Sources-general, Ships and Cruises, Textures-structures, ...12.0026

GEOPHYSICAL INVESTIGATIONS OF THE SOUTHWEST MARGIN OF JAPAN ...Japan, Ocean Basins, Regional Structure, Ships and Cruises, Trenches, ...7.0045

SEDIMENTATION, MORPHOLOGY, AND STRUCTURE--MID-ATLANTIC RIDGE ...Atlantic Ocean-general, Ocean History, Provenance Studies-other, Ridges, Sea Floor Spreading, ...7.0047

THE MARINE GEOLOGY OF THE SOUTHERN OCEAN ...Antarctic Ocean, Chemistry, Coring and Dredging, Mineralogy, Petrology, ...7.0067

A MICROPALEONTOLOGICAL STUDY OF DEEP-SEA CRETACEOUS AND TERTIARY SEDIMENT ...Biofacies, Microfossils, Physical Properties, Population - Distribution, Tertiary Period, ...7.0184

MARINE GEOLOGY OF THE SUB-ANTARCTIC PACIFIC REGION ...Antarctic Ocean, Core Analysis, Diagenesis, Origin, Petrology, Sedimentary History, ...7.0049

DEEP FLOW, WATER CHARACTERISTICS, TOPOGRAPHY AND SEDIMENTS IN THE CENTRAL PACIFIC AREA ...Abyssal, Currents-bottom, Geomorphology-topography, Pacific Ocean-general, Structural Studies, Water Motion Recorders, ...7.0032

SUPPORT OF RESEARCH VESSEL AT LAMONT GEOLOGICAL OBSERVATORY ...Marine Biology, Patterns, Ridges, Seismic Studies, Ships and Cruises, ...12.0037

OPTICAL OCEANOGRAPHY IN FLORIDA BAY, FLORIDA STRAITS AND BAHAMA BANK ...Mixing, Optical, Optical Devices, Sedimentation, Wind-water Interaction, ...1.0163

COLLECTION, REDUCTION, AND INTERPRETATION OF SEISMOLOGIC AND PHOTOGRAPHIC DATA ...Data Analysis - General, Environment, Ocean Basins, Photography, Sedimentary History, Sedimentation, Seismic Studies, ...7.0262

ESTUARINE SEDIMENTARY MODELS ...Circulation-general, Estuaries, Grain Size, Model Studies, Textures-structures, ...4.0079

SEDIMENT AND VOLCANIC STUDIES ...Origin, Pacific Ocean-north, Sedimentary Petrology, Stratigraphy-general, Volcanic, ...7.0189

DEEP SEA SEDIMENTS IN THE NORTH PACIFIC FROM STUDIES OF THEIR RADIOLARIAN CONTENT ...Biogenous, Core Analysis, Pacific Ocean-north, Protozoa - other, Sedimentation, ...7.0285

ROLE OF WIND-BORNE CONTINENTAL DUST IN OCEAN SEDIMENTATION PROCESSES ...Dust - Particulate Matter, Location, Rate of Deposition, Terrigenous, Trace Element Analysis, ...7.0230

HEAVY MINERAL DISTRIBUTION OF THE WHITE OAK ESTUARY-BOGUE INLET AREA, NORTH CAROLINA ...Bayous, Estuaries, Heavy Minerals, North Carolina, ...7.0269

A SEDIMENTOLOGIC STUDY OF MOBILE BAY AND PERDIDO BAY ...Alabama, Bays, Ocean History, Rate of Deposition, Stratigraphy-general, ...7.0231

MARINE BIOLOGY PROGRAM ...Productivity - Food Chain, Puerto Rico, Radioecology, Rare Earths, Trace Elements, ...1.0128

COASTAL AND CONTINENTAL SHELF SEDIMENTATION ...Argentina, Continental Shelf, Sediment Transport-other, Sedimentation, Shoreline - Coastline, ...7.0212

INTERPRETING THE ORIGIN AND DISTRIBUTION OF COASTAL SEDIMENTS ...Canada, Massachusetts, Origin, Shoreline - Coastline, Size, ...7.0213

MODERN VERSUS RELICT SEDIMENT PATTERNS ON CONTINENTAL MARGINS ...Bermuda, Canada, Continental Shelf, Quaternary Period, Sea Level Changes, ...7.0214

SEDIMENT DISPERSAL PATTERNS IN SUBMARINE CANYONS AND SUBSEA FANS ...Fans, Geologic Maps, North America, Submarine Canyons, Textures-structures, ...7.0215

SEA FLOOR STUDIES - DEPOSITIONAL AND EROSION PROCESSES ...Bearing Capacity, Erosion, Lithification-general, Sedimentation, Stability Analysis, ...7.0200

COASTAL PROCESSES - SOUTH TEXAS ...Depositional Features-other, Other Transport Methods, Rate of Deposition, Shoreline - Coastline, Texas, ...7.0219

MISSISSIPPI DELTA ...Deltas, Heavy Minerals, Mississippi, Ocean Mining, Potential of Deposit, Sedimentary History, ...7.0014

MARINE GEOLOGY STUDIES, GULF OF MEXICO-CARIBBEAN REGION ...Dimensions-distribution, Geology-general, Gulf of Mexico, Ocean Mining, Tectonics-general, ...7.0103

NEARSHORE HEAVY METAL DEPOSITS OF THE GULF OF ALASKA ...Deposits, Gulf of Alaska, Heavy Minerals, Mineral Concentration, Sedimentation, ...7.0019

NORTHERN CALIFORNIA OFFSHORE BLACK SANDS ...California, Heavy Minerals, Shoreline - Coastline, Size, Terrigenous, ...7.0020

SUBAERIAL AND SUBAQUEOUS FLOW OF SLURRIES ...Sedimentation, ...7.0222

OREGON-WASHINGTON NEARSHORE ...Heavy Minerals, Oregon, Shoreline - Coastline, Terrigenous, Washington, ...7.0022

GEOCHEMISTRY OF SAN FRANCISCO BAY ...Bays, Clays, Mineral Associations, San Francisco Bay, Trace Element Analysis, ...1.0074

ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...Clays, Organics, Sedimentation, ...1.0075

TESTING AND EVALUATION OF HIGH-RESOLUTION ACOUSTIC SUBBOTTOM PROFILER THROUGH MODIFI-

CATION OF OFF-THE-SHELF COMPONENTS ...Electric Circuits and Networks, Evaluation Other, Field Testing, Sonar, ...**8.0115**

SAMPLING CAMPAIGN ON CORONADO BANK, OFF SOUTHERN CALIFORNIA ...Banks, California, Chemistry, Coring and Dredging, Phosphate, Phosphite, ...**7.0003**

BOTTOM TOPOGRAPHY AND SEDIMENTS--MIDDLE ATLANTIC SHELF ...Continental Shelf, Geomorphology-topography, ...**4.0055**

SYSTEMS ANALYSIS FOR SHIPBORNE MUNICIPAL INCINERATION ...Incinerators, Ocean, Pollution Sources-other, Smoke, Solid Waste, ...**8.0327**

General Sediment Type

RESEARCH IN OCEANOGRAPHIC SPECIAL CHARTS ...Acoustical, Geomorphology-topography, Model Studies, Seismic Reflection, Seismic Studies, Subbottom, ...**1.0062**

Marine Soils

DEEP SEA SEDIMENT STUDIES ...Acoustical, Mechanical Properties, Physical Analysis, Physical Properties, Shear Strength, ...**8.0341**

ELECTROKINETIC SOIL STUDY ...Buried Structures, Electroosmosis, Electroosmosis, Electrophoresis, Laboratory Analysis, Stabilization, ...**8.0342**

EFFECTS OF DEEP SEA SEDIMENTS ON SUDDEN IMPACT, AS FROM DISASTER VEHICLES ...Coring and Dredging, Engineering Studies-other, Mechanical Properties, Physical Properties, Shear Strength, ...**7.0228**

OCEANOGRAPHIC RESEARCH ...Abyssal, Benthonic-bottom, Fouling, Geomorphology-topography, Tables, Compilations, Catalogs, ...**8.0343**

Mechanical Properties

DEEP SEA SEDIMENT STUDIES ...Acoustical, Marine Soils, Physical Analysis, Physical Properties, Shear Strength, ...**8.0341**

SEDIMENTATION ...Acoustical, Gravity Tectonics, Gulf of Mexico, Mass Wasting, Sedimentation, ...**7.0281**

SYMPOSIUM ON RESEARCH NEEDS AND PRIORITIES FOR MARINE GEOLOGY OF THE GULF OF MEXICO ...Continental Shelf, Gulf of Mexico, Instrumentation-general, Meetings, Sedimentation, Structural Studies, ...**11.0040**

SEISMIC, MAGNETIC, AND ACOUSTIC STUDIES ON THE CONTINENTAL MARGIN OFF WASHINGTON ...Acoustical, Continental Shelf, Subbottom, Textures-structures, Washington, ...**7.0151**

EFFECTS OF DEEP SEA SEDIMENTS ON SUDDEN IMPACT, AS FROM DISASTER VEHICLES ...Coring and Dredging, Engineering Studies-other, Marine Soils, Physical Properties, Shear Strength, ...**7.0228**

GEOLOGICAL OCEANOGRAPHY - ACOUSTICAL PROPERTIES OF SEDIMENTS ...Acoustical, Core Analysis, Geomorphology-topography, Physical Properties, Scattering, ...**7.0101**

BOTTOM SOIL PROPERTIES AND FOUNDATIONS ...Bearing Capacity, Consolidation, Foundations-general, Shear Strength, Soil Testing-general, ...**8.0332**

MARINE GEOLOGY OF THE SAN FRANCISCO BAY ...Bays, Geology-general, Gold, San Francisco Bay, Structural Studies, Tectogenesis, ...**7.0035**

DEVELOPMENT OF WIRE-LINE CORING TECHNIQUE FOR SAMPLING UNCONSOLIDATED DEPOSITS ...Alaska, Bottom Sampling Device, Coring and Dredging, Mineralogy, Technique Development, ...**8.0249**

LABORATORY MODEL STUDIES OF COMPARTIVE METHODS OF PENETRATION OF DETRITUS ...Disturbed/undisturbed, Ocean Mining, Rock Fragmentation Methods, Sand, Soil Sampling, ...**8.0257**

LABORATORY MODEL STUDIES OF PENETRATION INTO A SIMULATED COHESIONLESS DETRITUS ...Coring and Dredging, Gravel, Model Studies, Soil Sampling, Technique Development, ...**8.0245**

LABORATORY MODEL STUDIES ON DISTURBANCE OF DETRITUS BY PENETRATION ...Disturbed/undisturbed, Model Studies, ...**8.0252**

LABORATORY MODEL STUDIES ON PRESSURE DISTRIBUTION IN DETRITUS DURING PENETRATION ...Laboratory Analysis, Model Studies, Placer, Pressure, Soil Loads, ...**8.0253**

FINITE ELEMENT TECHNIQUES ...Distribution, Finite Differences, Mathematical Analysis, Model Studies, Rock Mechanics, ...**8.0254**

LABORATORY STUDIES TO CORRELATE ENGINEERING PROPERTIES OF MARINE PLACER MATERIALS WITH SAMPLING TOOL PERFORMANCE ...Coring and Dredging, Gold, Laboratory Analysis, Placer, Scientific-service-support, ...**8.0244**

Mineralogy

MARINE GEOCHEMISTRY RESEARCH ...Depth, Gases, Mineral Genesis, Radioactive Dating, Sedimentation, Thermodynamics, ...**7.0055**

ALTERATION OF MINERALS ...Aragonite, Chemistry, Saline Water Systems, Silicates, Solution Chemistry, ...**7.0056**

SUPPORT OF RESEARCH VESSELS JOHN ELLIOTT PILLSBURY, GERDA, TURSIOPS ...Microfossils, Paleotemperature, Petrology, Seismic Studies, Ships and Cruises, ...**12.0024**

THE MARINE GEOLOGY OF THE SOUTHERN OCEAN ...Antarctic Ocean, Chemistry, Coring and Dredging, Distribution, Petrology, ...**7.0067**

RARE GAS STUDY OF INTERPLANETARY MATERIAL IN PELAGIC SEDIMENTS ...Chemistry, Cosmogenous, Element Ratios, Equipment Purchase Operation, Mass Spectroscopy, X-ray, ...**7.0081**

STRUCTURE, MINERALOGY, AND CHEMICAL COMPOSITION OF MARINE MANGANESE NODULES ...Chemistry, Manganese, Origin, Polished Sections, Precipitates, Textures-structures, ...**7.0028**

STABLE ISOTOPE STUDIES ON COEXISTING MINERALS IN MARINE SEDIMENTS ...Coring and Dredging, Diagenesis, Genetic Relationships, Red Sea, Salinity, Thermal, ...**1.0106**

THE GEOCHEMISTRY, MINERALOGY AND ORIGIN OF PELAGIC SEDIMENTS IN AREAS OF HIGH HEAT FLOW AND FRACTURE ZONES ...Chemistry, Diagenesis, Geochemistry, Heat Flow Measurements, Origin, Sedimentation, ...**7.0227**

GEOCHEMICAL STUDIES OF DEEP-SEA DEPOSITS - THEIR SOURCES AND MODES OF DEPOSITION ...Abyssal, Atlantic Ocean-general, Biogenous, Biogeochemical Process, Chemistry, Ocean Bottom, ...**7.0057**

GEOPHYSICAL AND GEOCHEMICAL STUDY OF RED SEA MINERAL DEPOSITS ...Coring and Dredging, Gulf of Aden, Igneous Activity - Volcanism, Red Sea, Thermal, ...**7.0023**

MINERALOGICAL STUDIES OF PARTICULATE MATTER SUSPENDED IN SEA WATER ...Chemistry, Suspension, Water Chemistry-other, ...**1.0122**

DEEP-SEA SEDIMENTS AND VOLCANIC ROCKS OF MID-OCEAN RIDGES ...Origin, Ridges, Seamounts-guyots, Structural Studies, Tectonics-general, ...**7.0226**

JOINT STUDY OF THE CONTINENTAL MARGIN OFF OREGON BY OREGON STATE UNIVERSITY AND THE UNITED STATES GEOLOGICAL SURVEY ...Continental Shelf, Geophysics-general, Ocean Basins, Oregon, Potential of Deposit, ...**7.0046**

MARINE GEOLOGY OF THE CALIFRONIA CONTINENTAL BORDERLAND WITH EMPHASIS ON FUTURE ECONOMIC DEVELOPMENT AND GENERAL RESOURCE VALUE ...California, Clay Minerals-general, Continental Shelf, Heavy Elements, Ocean Mining, ...**7.0010**

RESEARCH ON MINERAL STRUCTURE REVEALED BY AN ELECTRON MICROSCOPE ...Comparative Anatomy, Electron Microscopy, Geologic, Paleontology, ...**7.0062**

OREGON-CALIFORNIA BLACK SANDS ...Beaches, California, Heavy Mineral Analysis, Heavy Minerals, Ocean Mining, Potential of Deposit, ...**7.0015**

HEAVY METALS AND SEDIMENTATION PROCESS OF THE NORTH CAROLINA SHELF ...Bottom Sampling Device, Continental Shelf, Heavy Minerals, North Carolina, Sedimentation, ...**7.0021**

UNIVERSITY OF SOUTHERN CALIFORNIA CONTRACT - CHANNEL ISLANDS AND BASINS SOUTHERN CALIFORNIA CONTINENTAL MARGIN ...California, Continental Shelf, Continents, General Mineralogic Properties, Geochronology-general, ...**7.0223**

DEVELOPMENT OF WIRE-LINE CORING TECHNIQUE FOR SAMPLING UNCONSOLIDATED DEPOSITS ...Alaska, Bottom Sampling Device, Coring and Dredging, Mechanical Properties, Technique Development, ...**8.0249**

PRELIMINARY STUDIES TO CORRELATE SELECTED MINERALOGIC AND GEOLOGIC PROPERTIES WITH EN-

GINEERING PROPERTIES ...Alaska, Engineering Geology, Petrology, Ships and Cruises, Trace Element Analysis, ...8.0169

Origin

THE CYCLE OF ORGANIC MATTER IN THE DEEP SEA ...Abyssal, Adsorption, Biogenous, Distribution, Marine Bacteria, ...1.0112

SUBMARINE TOPOGRAPHY ...Bathymetry, Pacific Ocean-south, Physiography-general, Sedimentation, Textures-structures, ...7.0299

DATING MARINE SEDIMENTS ...Argon-potassium, Loess, Optical, Radioactive Dating, Rate of Deposition, Terrigenous, ...7.0201

MARINE GEOLOGY OF THE SUB-ANTARCTIC PACIFIC REGION ...Antarctic Ocean, Core Analysis, Diagenesis, Distribution, Petrology, Sedimentary History, ...7.0049

STRUCTURE, MINERALOGY, AND CHEMICAL COMPOSITION OF MARINE MANGANESE NODULES ...Chemistry, Manganese, Mineralogy, Polished Sections, Precipitates, Textures-structures, ...7.0028

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CONTINENTAL MARGIN GEOLOGY ...Bay of Bengal, Continental Shelves, Seismic Reflection, Subbottom, Textures-structures, ...7.0030

NATURE AND VELOCITY OF CURRENTS AND OTHER FLOWS IN SUBMARINE CANYONS ...Convection, Ocean Waves - Currents, Sedimentation, Submarine Canyons, Turbidity Currents, Water Motion Recorders, ...2.0008

SEDIMENT DISPERSAL PATTERNS IN SUBMARINE CANYONS AND SUBSEA FANS ...Distribution, Geologic Maps, North America, Submarine Canyons, Textures-structures, ...7.0215

Faults

CONTINUITY OF CLIPPERTON AND CLARION FRACTURE ZONES ...Costa Rica, Geomorphology-topography, Gravity Studies, Seismic Reflection, Structural Studies, ...7.0090

Geomorphology-topography

DEEP SUBMERGENCE SYSTEMS ...Buoyant, Flotational, Marine Propulsion, Navigation Communication, Physical Properties, Submersibles, Welding - Other, ...8.0051

FEASIBILITY STUDY FOR SYNTHETIC APERTURE ARRAY ACOUSTIC BOTTOM MAPPING SYSTEM ...Acoustic, Charts, Doppler, Mapping, ...4.0061

VISIBLE REGION INSTRUMENTATION FOR OCEANOGRAPHIC SATELLITES ...Currents-ocean, Mapping, Photography, Satellites, Shoals, ...8.0088

MARINE GEOLOGY ...Acoustical, Bathymetry, Magnetic Studies, Mapping, Sea Floor Spreading, ...7.0041

ARCTIC RESEARCH ...Acoustical, Arctic Ocean, Currents-ocean, Magnetic Studies, Sea Ice, ...4.0049

SEA FLOOR TOPOGRAPHY ...Abyssal, Acoustical, Seamounts-guyots, Sedimentation, Structural Studies, ...7.0294

MARINE GEOPHYSICS ...Caribbean Sea, Geophysical Equipment, Heat Flow Measurements, Magnetic Studies, Structural Studies, ...7.0115

GEOTHERMAL MEASUREMENTS ...Geothermal Gradient, Heat Flow Measurements, Physical Analysis, Physical Properties, Temperature, ...7.0136

NORTH ATLANTIC CIRCULATION ...Atlantic Ocean-north, Circulation-general, Gulf Stream, Hydrodynamics, Oceanic Fronts, ...2.0031

SUBMARINE CANYONS ...California, Development, Erosional Features, Photography, Submarine Canyons, ...7.0295

SUPPORT OF UNIVERSITY OF GEORGIA MARINE INSTITUTE RESEARCH VESSEL OPERATION ...Continental Shelf, Continental Slope, Distribution, Environmental Ecology, Estuaries, Marine Biology, Pollution Sources-general, Ships and Cruises, Textures-structures, ...12.0026

REDUCTION AND INTERPRETATION OF PHYSIOGRAPHIC DATA ACQUIRED ABOARD LAMONT RESEARCH VESSELS ...Data Analysis - General, Data Reduction and Analysis, Geology-general, Ocean Basins, Physiography-general, ...7.0300

DEEP FLOW, WATER CHARACTERISTICS, TOPOGRAPHY AND SEDIMENTS IN THE CENTRAL PACIFIC AREA ...Abyssal, Currents-bottom, Distribution, Pacific Ocean-general, Structural Studies, Water Motion Recorders, ...7.0032

REFLECTION PROFILING OF THE SEA FLOOR ...Atolls, Continental Shelves, Fault Complexes, Pacific Ocean-general, Seismic Reflection, ...7.0091

OPERATION OF R/V TRIDENT ...Phytoplankton, Sea Floor Spreading, Ships and Cruises, Sound Production, Subbottom, Vertical Distribution, ...12.0045

THEORETICAL STUDIES OF TSUNAMI PROPAGATION ...Depth, Environmental Effects-geologic, Forecasting-prediction, Tsunami, Waves, ...2.0122

TIME FLUCTUATIONS IN OCEAN CURRENTS ...Currents-ocean, Model Studies, Testing of Models, Waves, ...2.0039

CONTINUITY OF CLIPPERTON AND CLARION FRACTURE ZONES ...Costa Rica, Faults, Gravity Studies, Seismic Reflection, Structural Studies, ...7.0090

SEDIMENT-FLUID INTERACTIONS ...Flow of Dispersed Solids, Sedimentation, Textures-structures, Wave Action, Waves-internal, ...7.0245

RESEARCH IN CORE ANALYSIS ...Acoustical, Core Analysis, Coring and Dredging, Model Studies, Physical Properties, ...7.0263

RESEARCH IN OCEAN PROPERTIES ...Acoustical, Geophysical Equipment, Marine Biology, Model Studies, Seismic Studies, Subbottom, ...7.0132

RESEARCH IN OCEANOGRAPHIC SPECIAL CHARTS ...Acoustical, General Sediment Type, Model Studies, Seismic Reflection, Seismic Studies, Subbottom, ...1.0062

MULTISPECTRAL SENSING OF COASTAL ENVIRONMENTS ...Aerial Photography, Beaches, Depth, E M Radiation-general, Photography, Shoreline - Coastline, ...4.0166

OCEANOGRAPHIC RESEARCH ...Abyssal, Benthonic-bottom, Fouling, Marine Soils, Tables, Compilations, Catalogs, ...8.0343

RESEARCH IN REGIONAL TOPOGRAPHIC ANALYSIS ...Acoustical, Seismic Studies, Sonar, Subbottom, ...1.0063

WOODS HOLE ENVIRONMENTAL STUDIES OF SEA FLOOR PROPERTIES ...Acoustical, Benthonic-bottom, Data Acquisition, Gravity Studies, Subbottom, ...7.0118

AN ANALYTICAL AND EXPERIMENTAL STUDY OF BED FORMS UNDER WATER WAVES ...Channel Roughness, Friction, Model Studies, Water Tunnels Tables, Wave Action, Waves, ...2.0110

SEA SLED AND SCUBA RECONNAISSANCE OF INSHORE AND STUDIES ON EFFECT OF ARTIFICIAL SHELTERS ON STANDING CROP OF FISHES ...Coastlines-shorelines, Diving and Scuba, Fish -non-specific, Hawaii, Management - other, ...9.0008

EVALUATION AND STATISTICAL ANALYSIS OF ALL DATA ...Data Analysis - General, Mapping, Spawning & Nesting Sites, Statistics-general, ...4.0018

GEOLOGICAL AND HYDROGRAPHIC STUDY OF THE WILMINGTON SUBMARINE CANYON AND ADJACENT AREAS ...Bottom Sampling Device, Model Studies, Photography, Submarine Canyons, Textures-structures, ...7.0211

SHALLOW WATER ACOUSTIC PROPAGATION STUDIES (SWAPS) ...Acoustical, Liquids, Subbottom, Thermal, Transmission, Turbulence - Sea Water, Water Motion, Waves, ...1.0065

SEA FLOOR STUDIES - TOPOGRAPHY AND SHAPE OF THE SEA FLOOR ...Acoustical, Photography, Sedimentation, ...7.0293

GEOLOGICAL OCEANOGRAPHY - ACOUSTICAL PROPERTIES OF SEDIMENTS ...Acoustical, Core Analysis, Mechanical Properties, Physical Properties, Scattering, ...7.0101

GLOBAL OCEAN FLOOR ANALYSIS ...Acoustical, Bathymetry, Benthonic-bottom, Currents-bottom, Seismic Studies, Subbottom, ...4.0046

MEASUREMENT AND PREDICTIVE STATISTICS OF REVERBERATION ...Acoustical, Reverberation, Scattering, Surface Environments, Textures-structures, Velocity, ...1.0007

DIVER-ASSISTED OCEANOGRAPHY ...Benthonic-bottom, Continental Shelf, Currents-bottom, Diving and Scuba, Mapping, Waves-internal, ...4.0098

MECHANICS OF WAVE ACTION IN DEEP AND SHALLOW WATER ...Currents-longshore, Sand Bars, Tsunami, Waves, Waves-internal, ...2.0100

DEVELOPMENT OF NEW FISHING TECHNIQUES ...Commercial Fishing, Diving and Scuba, Fishing Gear, Mark, Tag Or Capture -other, Photography, Telemetry, ...8.0151

BOTTOM TOPOGRAPHY AND SEDIMENTS--MIDDLE ATLANTIC SHELF ...Continental Shelf, Distribution, ...4.0055

Islands

MESO AND CONVECTIVE SCALE SYSTEMS IN THE MARITIME TROPICAL ATMOSPHERE ...Air Motion-general, Convection, Heat Budget, Meteorologic Model Studies, Tropic, ...3.0062

SYSTEMATICS, MORPHOLOGY, AND ECOLOGICAL DISTRIBUTION OF ALGO AND WOOD-INHABITING MARINE AND FRESHWATER FUNGI OF SURTSEY AND ICELAND ...Aquatic Fungi (non-specific), Iceland, Marine Fungi (non-specific), Plant Taxonomy, Range Or Territorial Distr. , ...5.0714

HAWAIIAN OCEANOGRAPHY ...Circulation-general, Environmental Effects-geologic, Hawaii, Hydrodynamics, Ocean Currents-other, ...2.0021

BIOLOGICAL COLONIZATION OF A RECENTLY FORMED ISLAND ...Habitat Studies, Iceland, Productivity - Food Chain, Succession, Volcanoes, ...5.0925

CIRCULATION AROUND OCEANIC ISLANDS ...Circulation-general, Density, Mixing, Thermodynamics, Waves-internal, Wind-water Interaction, ...2.0010

ISLAND-CURRENT INTERACTIONS ...Acoustical, Currents-ocean, Data Analysis - General, Geomorphology, Model Studies, ...2.0116

MARINE BIOLOGY STUDIES ON FAIRFAX ISLAND ...Australia, Collections, Data Acquisition, Marine Biology, Reefs, ...5.0874

ISLAND STUDY ...Conservation-general, Land Economics, Recreation Sites, Types of Resources, United States-general, ...9.0005

Reefs

ORGANIC PRODUCTION OF EPIFAUNAL ORGANISMS ...Energy Budgets, Epiphytic Relationships, Marine Biology (non-specific), Organics, Plant Ecosystems(non-specific), Primary Productivity, ...5.1032

STRUCTURE OF THE FISH FAUNA OF A FLORIDA CORAL REEF ...Ecological, Fish -non-specific, Vertical Distribution, ...5.0205

ECOLOGY OF THE PORITES FURCATA REEF-FLAT COMMUNITY ...Anthozoa, Panama, Productivity - Food Chain, Puerto Rico, ...5.0867

ENVIRONMENTAL SIGNIFICANCE OF SABELLARIID REEFS ...Biology, Habitat Studies, Lugworms, Marine Segmentedworm, ...5.0592

SYSTEMATIC STUDIES OF SPONGES OF THE JAMAICAN FORE-REEF SLOPE ...Animal Taxonomy, Habitat Studies, Invertebrate Anatomy, Jamaica, Porifera, ...5.0558

ISOTOPIC AND CHEMICAL COMPOSITION OF ORGANIC CARBONATES ...Biochemical, Chemical, Jamaica, Organic Limestone, Sedimentary Petrogenesis, ...7.0084

EFFECTS OF HURRICANE BETSY ON SOME BEHAMA CORAL REEFS ...British West Indies, General Deposition, Tropical Cyclones, ...7.0290

CARBON-14 AGE PROFILE OF A HAWAIIAN REEF ...Anthozoa, Carbon-14, Coring and Dredging, Growth Rate, Hawaii, Sea Level Variations, ...7.0051

INVESTIGATION OF QUATERNARY SEA LEVEL CHANGES IN THE CAROLINE AND MARSHALL ISLANDS ...Carbon-14, Emergent, Pacific Ocean-south, Quaternary Period, Sea Level Variations, ...7.0159

FLORIDA CORAL REEF STUDIES ...Drilling and Coring, Environment, Florida, Geologic History-general, Quaternary Period, ...7.0162

RADIOCARBON DATING OF A HAWAIIAN REEF PROFILE ...Carbon-14, Hawaii, Radioactive Dating, Sea Level Variations, ...7.0087

EXPERIMENTAL CULTURE OF CALCAREOUS GREEN ALGAE OF CORAL REEFS ...Algal Culture, Biology, Calcium, Chlorophyceae (non-specif.&ot), Growth and Differentiation, Plant Taxonomy, ...5.0719

MARINE BIOLOGY STUDIES ON FAIRFAX ISLAND ...Australia, Collections, Data Acquisition, Islands, Marine Biology, ...5.0874

THE BIOLOGY OF ROCK-BORING SIPUNCULIDS ...Caribbean Sea, Invertebrate Nutrition, Invertebrate Physiology, Invertebrates -non-specific, ...5.0577

PRE-CONSTRUCTION ENVIRONMENTAL SURVEY ...Construction Land Use Effects, Construction Sites, Continental Shelf, Environmental Ecology, Organism Sampling Devices, ...5.0907

Ridges

DEVELOPMENT OF A SENSOR, INSTRUMENTATION AND COMMUNICATION SYSTEM FOR A DEEP OCEAN MANNED HABITAT (ATLANTIS) ...Continental Shelf, Navigation Communication, Safety, Submersibles, Underwater-laboratory, ...8.0107

RADIOELEMENT STUDIES IN THE OCEANS - GEOLOGY AND GEOCHEMISTRY ABOUT THE MID-ATLANTIC

RIDGE ...Adsorption Capacity, Chemistry, Isotope, Removal--inorganics, Water Analysis, ...7.0072

AZORES VOLCANIC STUDY ...Atlantic Ocean-general, Azores, Element Ratios, Igneous Activity - Volcanism, Volcanic, ...8.0195

MAGNETICS ...Anomalies, Atlantic Ocean-north, Pacific Ocean-general, Sea Floor Spreading, Trenches, ...7.0135

STRUCTURE OF OCEAN BASINS ...Basins, Bathymetry, Charts, Indian Ocean-general, Structural Studies, ...7.0092

MARINE SEDIMENTS ...Atlantic Ocean-south, Bathymetry, Magnetic Studies, Sea Floor Spreading, Textures-structures, ...7.0203

ACQUISITION, REDUCTION AND INTERPRETATION OF MARINE MAGNETIC DATA ...Anomalies, Data Acquisition, Data Reduction and Analysis, Magnetic Studies, ...4.0032

ACQUISITION AND INTERPRETATION OF OCEANIC GRAVITY DATA ...Analog Computer Applications, Data Reduction and Analysis, Gravity Studies, Structural Analysis, Trenches, ...4.0033

ANALYSIS OF SEISMIC DATA COLLECTED DURING THE INTERNATIONAL INDIAN OCEAN EXPEDITION AND IN THE CARIBBEAN SEA ...Basins, Data Analysis - General, Indian Ocean-general, Seismic Reflection, Textures-structures, ...7.0119

SEDIMENTATION, MORPHOLOGY, AND STRUCTURE--MID-ATLANTIC RIDGE ...Atlantic Ocean-general, Distribution, Ocean History, Provenance Studies-other, Sea Floor Spreading, ...7.0047

SUBMARINE GEOLOGY OF THE BAHAMAS AND THE WEST INDIAN ARC ...British West Indies, Geology-general, Ocean Basins, Ships and Cruises, Trenches, ...7.0038

SUPPORT OF RESEARCH VESSEL AT LAMONT GEOLOGICAL OBSERVATORY ...Distribution, Marine Biology, Patterns, Seismic Studies, Ships and Cruises, ...12.0037

A STUDY OF THE STRUCTURAL RELATIONS BETWEEN THE MID-PACIFIC OCEANIC RIDGES AND FRACTURE ZONES ...Anomalies, Ocean History, Polynesia, Structural Studies, Tectogenesis, ...7.0111

GEOCHEMISTRY OF MID-ATLANTIC RIDGE SEDIMENTS ...Atlantic Ocean-general, Chemistry, Core Analysis, Correlation, Geochronology-general, ...7.0071

PETROLOGY AND GEOCHEMISTRY OF IGNEOUS ROCKS FROM THE OCEAN FLOOR ...Argon-potassium, Extrusives, Pacific Ocean-east, Petrography, Petrology, Sima, ...7.0064

DEEP OCEAN AS RECIPIENT OF VOLATILES AND SOLUTES ...Hydrothermal Minerals, Igneous Activity - Volcanism, Lithology, Pacific Ocean-east, Sea Floor Spreading, Thermal Features, Water Analysis-general, ...7.0095

GEOPHYSICAL AND GEOLOGICAL STUDY OF THE DARWIN RISE ...Bathymetry, Coring and Dredging, Geophysics-general, Gravity Studies, Magnetic Studies, Ocean Basins, Pacific Ocean-west, Photography, Refraction, Seamounts-guyots, ...7.0112

HEAT FLOW MEASUREMENTS ...Basins, Heat Flow Measurements, Melanesia, Philippines, Temperature, ...7.0100

GEOTHERMAL INVESTIGATIONS IN OCEAN REGIONS ...Atlantic Ocean-general, Heat Flow Measurements, Oceanic - Pelagic, Sediments-other, Temperature, ...7.0123

DEEP-SEA SEDIMENTS AND VOLCANIC ROCKS OF MID-OCEAN RIDGES ...Mineralogy, Origin, Seamounts-guyots, Structural Studies, Tectonics-general, ...7.0226

UPPER MANTLE OF OCEAN REGIONS ...Earth Interior, Extrusives, High Pressure Research, High Temperature Research, Lava, Petrology, ...7.0053

SEA-FLOOR SEDIMENTS AND ROCK STUDIES ...Atlantic Ocean-north, Biogenous, Core Analysis, Microfossils, Paleomagnetism, Petrology, Sedimentation, ...7.0040

GEOMAGNETIC INVESTIGATIONS ...Anomalies, Gravity Studies, Magnetometers, Sea Floor Spreading, Structural Studies, ...7.0120

AGE RELATIONS OF IGNEOUS ROCKS FROM THE MID-ATLANTIC RIDGE ...Extrusives, Foliated Rocks, Geologic Age Relations, Rare Earth Studies, Trace Element Analysis, ...7.0080

BIOSTRATIGRAPHY OF MID-ATLANTIC RIDGE SEDIMENTS ...Biofacies, Biogenous, Correlation, Ocean History, Order Foraminifera, ...7.0209

Seamounts-guyots

SEA FLOOR TOPOGRAPHY ...Abyssal, Acoustical, Geomorphology-topography, Sedimentation, Structural Studies, ...7.0294

RECENT AND ANCIENT FAUNAS OF A DROWNED ISLAND CHAIN (MID-PACIFIC MOUNTAINS) ...Benthic Fauna, Biofacies, Coring and Dredging, Hawaii, ...5.0863

GEOPHYSICAL AND GEOLOGICAL STUDY OF THE DARWIN RISE ...Bathymetry, Coring and Dredging, Geophysics-general, Gravity Studies, Magnetic Studies, Ocean Basins, Pacific Ocean-west, Photography, Refraction, Ridges, ...7.0112

THE MAGNETIZATION OF SUBMARINE BASALTS AND ITS EFFECT ON MARINE MAGNETIC ANOMALIES ...Anomalies, Extrusives, Field Reversals, Magnetic Studies, Paleomagnetism, ...7.0153

DEEP-SEA SEDIMENTS AND VOLCANIC ROCKS OF MID-OCEAN RIDGES ...Mineralogy, Origin, Ridges, Structural Studies, Tectonics-general, ...7.0226

SEA USE ...General Synoptic Observations, Marine Biology, Oceanography-general, Pacific Ocean-east, Platforms, ...7.0303

SEAMOUNT INVESTIGATION ...Anomalies, Data Analysis - General, Geothermal, Magnetic Studies, Ocean Mining, Sonar, ...7.0107

Structural Studies

STUDY OF EARTH NOISE ON LAND AND SEA BOTTOM ...Microseisms - Background, Ocean Basins, Propagation, Seismic Studies, ...7.0094

SEA FLOOR TOPOGRAPHY ...Abyssal, Acoustical, Geomorphology-topography, Seamounts-guyots, Sedimentation, ...7.0294

MARINE GEOPHYSICS ...Caribbean Sea, Geomorphology-topography, Geophysical Equipment, Heat Flow Measurements, Magnetic Studies, ...7.0115

STRUCTURE OF OCEAN BASINS ...Basins, Bathymetry, Charts, Indian Ocean-general, Ridges, ...7.0092

ANALYSES OF ROCKS COLLECTED IN THE INDIAN AND ATLANTIC OCEANS ...Atlantic Ocean-general, Crust, Indian Ocean-general, Ocean Basins, Petrology, ...7.0073

OPERATIONAL SUPPORT OF OCEANOGRAPHIC RESEARCH VESSELS ...Facilities, Geophysics-general, Hawaii, Sediments-general, ...12.0027

DEEP FLOW, WATER CHARACTERISTICS, TOPOGRAPHY AND SEDIMENTS IN THE CENTRAL PACIFIC AREA ...Abyssal, Currents-bottom, Distribution, Geomorphology-topography, Pacific Ocean-general, Water Motion Recorders, ...7.0032

TECTONIC AND GEOLOGICAL HISTORY OF THE SOUTHWEST PACIFIC REGION ...Gases, Geophysics-general, Island Arcs, Oceans - Sea Water, Pacific Ocean-south, Tectonics-general, ...7.0031

SYMPOSIUM ON RESEARCH NEEDS AND PRIORITIES FOR MARINE GEOLOGY OF THE GULF OF MEXICO ...Continental Shelf, Gulf of Mexico, Instrumentation-general, Mechanical Properties, Meetings, Sedimentation, ...11.0040

GEOPHYSICAL INVESTIGATIONS IN THE CORAL SEA ...Buoys, Coral Sea, Crust, Regional Structure, Seismic Refraction, ...7.0130

A STUDY OF THE STRUCTURAL RELATIONS BETWEEN THE MID-PACIFIC OCEANIC RIDGES AND FRACTURE ZONES ...Anomalies, Ocean History, Polynesia, Ridges, Tectogenesis, ...7.0111

UNDERWATER CAMERA SYSTEM ...Equipment Purchase Operation, Pacific Ocean-north, Photography, Sediments-general, ...8.0154

CONTINUITY OF CLIPPERTON AND CLARION FRACTURE ZONES ...Costa Rica, Faults, Geomorphology-topography, Gravity Studies, Seismic Reflection, ...7.0090

DEEP-SEA SEDIMENTS AND VOLCANIC ROCKS OF MID-OCEAN RIDGES ...Mineralogy, Origin, Ridges, Seamounts-guyots, Tectonics-general, ...7.0226

GRAVITY SURVEY ARCTIC OCEAN ...Bathymetry, Beaufort Sea, Continental Shelf, Geodetic Surveys, Gravity Studies, Seismic Studies, ...7.0154

GEOPHYSICS, GULF OF MEXICO ...Gulf of Mexico, Ocean Basins, Regional Structure, Seismic Studies, Trenches, ...7.0148

GEOMAGNETIC INVESTIGATIONS ...Anomalies, Gravity Studies, Magnetometers, Ridges, Sea Floor Spreading, ...7.0120

DEEP OCEAN RESEARCH AND DEEP OCEAN ENGINEERING ...Abyssal, Engineering Studies-general, Geophysics-general, Marine Biology, Submersibles, Textures-structures, ...4.0131

MARINE GEOLOGY OF THE SAN FRANCISCO BAY ...Bays, Geology-general, Gold, Mechanical Properties, San Francisco Bay, Tectogenesis, ...7.0035

CENTRAL CALIFORNIA CONTINENTAL MARGIN ...California, Continental Shelf, Continental Slope, Geologic Maps, San Andreas Fault, ...7.0036

Subbottom

EXPERIMENTAL HIGH RESOLUTION SUB-BOTTOM PROFILING SYSTEM ...Amplifiers, Receivers, Sonar, Sonar and Echo Sounding, Transducers, ...8.0109

SUBMARINE GEOLOGY OF GASTINEAU CHANNEL JUNEAU, ALASKA ...Alaska, Basins, Distribution, Seismic Studies, Size, ...7.0191

SUBMARINE SEISMIC PROFILES OF THE WORLDS OCEANS ...Atlantic Ocean-general, Cables and Transmission Lines, Data Analysis - General, Indian Ocean-general, Seismic Studies, ...7.0150

MARINE SEDIMENTS ...Biology, Chemistry, Core Analysis, Physical Properties, Textures-structures, ...7.0264

CONTINENTAL MARGIN GEOLOGY ...Bay of Bengal, Continental Shelves, Fans, Seismic Reflection, Textures-structures, ...7.0030

DETAILED STUDY OF THE OCEANIC CRUST BY MEANS OF DEEP SEISMIC PROFILING ...Continental Shelves, Heat Flow Measurements, Seismic Studies, Textures-structures, Washington, ...7.0152

OPERATION OF R/V TRIDENT ...Geomorphology-topography, Phytoplankton, Sea Floor Spreading, Ships and Cruises, Sound Production, Vertical Distribution, ...12.0045

SEISMIC, MAGNETIC, AND ACOUSTIC STUDIES ON THE CONTINENTAL MARGIN OFF WASHINGTON ...Acoustical, Continental Shelf, Mechanical Properties, Textures-structures, Washington, ...7.0151

RESEARCH IN OCEAN PROPERTIES ...Acoustical, Geomorphology-topography, Geophysical Equipment, Marine Biology, Model Studies, Seismic Studies, ...7.0132

RESEARCH IN OCEANOGRAPHIC SPECIAL CHARTS ...Acoustical, General Sediment Type, Geomorphology-topography, Model Studies, Seismic Reflection, Seismic Studies, ...1.0062

RESEARCH IN REGIONAL TOPOGRAPHIC ANALYSIS ...Acoustical, Geomorphology-topography, Seismic Studies, Sonar, ...1.0063

WOODS HOLE ENVIRONMENTAL STUDIES OF SEA FLOOR PROPERTIES ...Acoustical, Benthonic-bottom, Data Acquisition, Geomorphology-topography, Gravity Studies, ...7.0118

SHALLOW WATER ACOUSTIC PROPAGATION STUDIES (SWAPS) ...Acoustical, Geomorphology-topography, Liquids, Thermal, Transmission, Turbulence - Sea Water, Water Motion, Waves, ...1.0065

ACOUSTIC PROPERTIES OF SEDIMENTS ...Acoustical, Correlation, Physical Properties, Seismic Studies, Texture, ...7.0108

GLOBAL OCEAN FLOOR ANALYSIS ...Acoustical, Bathymetry, Benthonic-bottom, Currents-bottom, Geomorphology-topography, Seismic Studies, ...4.0046

Submarine Canyons

MARINE GEOLOGY ...California, Continental Shelf, Distribution, Ocean Waves - Currents, Sedimentation, ...7.0260

SAND TRANSPORT ...Beach, Ocean Waves - Currents, Sand Bars, Sedimentation, Textures-structures, ...7.0202

SUBMARINE CANYONS ...California, Development, Erosional Features, Geomorphology-topography, Photography, ...7.0295

NATURE AND VELOCITY OF CURRENTS AND OTHER FLOWS IN SUBMARINE CANYONS ...Convection, Fans, Ocean Waves - Currents, Sedimentation, Turbidity Currents, Water Motion Recorders, ...2.0008

GEOLOGIC SURVEY OF MARTABAN CANYON, NORTHEASTERN INDIAN OCEAN ...Andaman Sea, River Deltas, Sedimentary History, Tectogenesis, Valleys, ...7.0039

OCEAN CIRCULATION ...California Current, Circulation-general, Forecasting-prediction, Hydrodynamics, Model Studies, ...2.0002

GEOLOGICAL AND HYDROGRAPHIC STUDY OF THE WILMINGTON SUBMARINE CANYON AND ADJACENT AREAS ...Bottom Sampling Device, Geomorphology-topography, Model Studies, Photography, Textures-structures, ...7.0211

SEDIMENT DISPERSAL PATTERNS IN SUBMARINE CANYONS AND SUBSEA FANS ...Distribution, Fans, Geologic Maps, North America, Textures-structures, ...7.0215

Trenches

MARINE BIOLOGY IN ALASKA ...Alaska, Amino Acids -non-specific, Polar, Porifera, ...5.0854

MAGNETICS ...Anomalies, Atlantic Ocean-north, Pacific Ocean-general, Ridges, Sea Floor Spreading, ...7.0135

HEAT FLOW AND MAGNETICS IN THE PHILIPPINE SEA ...Arcs, Heat Flow Measurements, Magnetic Studies, Philippine Sea, Sea Floor Spreading, ...7.0137

GEOPHYSICAL INVESTIGATIONS OF THE SOUTHWEST MARGIN OF JAPAN ...Distribution, Japan, Ocean Basins, Regional Structure, Ships and Cruises, ...7.0045

ACQUISITION AND INTERPRETATION OF OCEANIC GRAVITY DATA ...Analog Computer Applications, Data Reduction and Analysis, Gravity Studies, Ridges, Structural Analysis, ...4.0033

SUBMARINE GEOLOGY OF THE BAHAMAS AND THE WEST INDIAN ARC ...British West Indies, Geology-general, Ocean Basins, Ridges, Ships and Cruises, ...7.0038

ROCK SAMPLING AND GEOPHYSICAL STUDIES IN THE TONGA KERMADEC TRENCH SOUTHWEST PACIFIC ...American Samoa, Coring and Dredging, Equipment Purchase Operation, Pacific Ocean-west, Photography, Seismic Reflection, ...7.0093

GEOPHYSICS, GULF OF MEXICO ...Gulf of Mexico, Ocean Basins, Regional Structure, Seismic Studies, Structural Studies, ...7.0148

IGNEOUS AND SEDIMENTARY ROCKS FROM THE NORTH WALL OF THE PUERTO RICO TRENCH ...Igneous Rocks, Petrology, Puerto Rico, Sedimentary Rocks, ...7.0083

Valleys

GEOLOGIC SURVEY OF MARTABAN CANYON, NORTHEASTERN INDIAN OCEAN ...Andaman Sea, River Deltas, Sedimentary History, Submarine Canyons, Tectogenesis, ...7.0039

Oceanic - Pelagic

INVESTIGATE METHODOLOGY FOR MEASURING OCEANIC PROPERTIES LEADING TO THE TOTAL ENVIRONMENTAL SURVEY OF A SELECTED OCEAN AREA ...Coring and Dredging, Physical Properties, Radioactivity, Submersibles, Technique Development, ...8.0061

GEOTHERMAL INVESTIGATIONS IN OCEAN REGIONS ...Atlantic Ocean-general, Heat Flow Measurements, Ridges, Sediments-other, Temperature, ...7.0123

PRELIMINARY TESTING OF PELAGIC TRAWLS ON SMALL DRAGGERS ...Barges-towboats, Fishing Gear, Nets, ...8.0143

WAVE MEASUREMENT IN THE OPEN OCEAN ...Buoys, Data Acquisition, Profiles, Water Motion Recorders, Waves, ...2.0109

PELAGIC TRAWL ...Nets, Other-design-and-construction, Special Mission Ships, ...8.0134

MULTISPECIES FISHERIES MODELS ...California, Commercial Fishing, Economics, Model Studies, Pacific Ocean-east, Production & Processing, ...4.0065

THE STRUCTURE AND FUNCTION OF CRUSTACEAN EYES ...Crustacea -non-specific, Invertebrate Anatomy, Light -other, Vertical Distribution, Visual Organs, ...5.0363

Oceanic Fronts

COLUMBIA RIVER EFFECTS IN THE NORTHEAST PACIFIC ...Bed Load, Benthonic-bottom, Columbia River, Mixing, Ocean Waves - Currents, ...2.0065

RADIOELEMENT STUDIES IN THE OCEANS - LANTHANIDES IN SEA WATER AND THEIR INTERACTIONS WITH MARINE SEDIMENTS AND SUSPENSOIDS ...Atlantic Ocean-general, Lanthanide Series, Radiochemical Analysis, Trace Elements, Water Analysis, ...1.0104

OCEAN CIRCULATION AND CONTROLLING FACTORS FOR PREDICTION ...Circulation-general, Meteorological Studies, Salinity, Temperature, ...2.0034

NORTH ATLANTIC CIRCULATION ...Atlantic Ocean-north, Circulation-general, Geomorphology-topography, Gulf Stream, Hydrodynamics, ...2.0031

INDUCTION IN THE OCEAN ...Crust, Currents-ocean, Earth Interior, Fluctuations, Induction, ...1.0137

CIRCULATION OF THE PACIFIC ...Circulation-general, Density, Pacific Ocean-general, Sampling, Subsurface Environments, ...2.0007

OCEAN-ATMOSPHERE STUDIES WITH STABLE ISOTOPES AND DISSOLVED GASES ...Air-sea Boundary-general, Equilibrium - Chemical, Gases, Mixing, Particle-gas Transfer, Tracers, ...3.0005

PHYSICAL AND CHEMICAL PROPERTIES OF THE SHELF AND SLOPE WATERS OFF NORTH CAROLINA ...Atlantic Ocean-north, Continental Shelf, General Sea Water Chemistry, North Carolina, Water Properties-general, ...1.0156

AN INVESTIGATION OF THE OVERFLOW OF NORWEGIAN SEA WATER INTO THE NORTH ATLANTIC THROUGH DENMARK STRAIT ...Atlantic Ocean-north, Norwegian Sea, Ocean Currents-other, ...2.0032

AIRBORNE SEA SURFACE MEASUREMENTS IN THE EQUATORIAL PACIFIC ...Atolls, Humidity, Infrared Radiation, Mapping, Radiation Detection, Temperature, ...1.0190

FORMATION OF ANTARCTIC BOTTOM WATERS ...Buoys, Hydrodynamics, Salinity, Temperature, Weddell Sea, ...1.0152

STRATIGRAPHY OF UNCONSOLIDATED SEDIMENTS ON THE CONTINENTAL SHELVES OF THE CHUKCHI AND NORTHERN BERING SEAS ...Bering Sea, Chuckchi Sea, Continental Shelf, Core Analysis, Correlation, Sedimentary History, ...7.0286

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FAMILIAL RELATIONSHIPS IN TELEOST FISHES ...Animal Taxonomy, Fish -other, Genetic, Karyotypes, Nomenclature, Classification, ...5.0148

A SYSTEMATIC REVISION OF THE HOLOTHURIAN FAMILY PSOLIDAE - ECHINODERMATA - HOLOTHUROIDEA ...Animal Taxonomy, Classification - Taxonomy, Modern Organisms, Nomenclature, Classification, Sea Cucumber, ...5.0572

RESEARCH ON MINERAL STRUCTURE REVEALED BY AN ELECTRON MICROSCOPE ...Electron Microscopy, Geologic, Mineralogy, Paleontology, ...7.0062

Comparative Physiology

COMPARATIVE STUDY OF NITROGEN SECRETION IN FISHES ...Fish, Metabolism, Nitrogen, Vertebrate Anatomy, ...5.1022

EVOLUTIONARY DIVERGENCE OF DEEP WATER MARINE ANNELIDS ...Digestive System, Environmental Physiology, Lugworms, Marine Segmentedworm, Vertical Distribution, ...5.0662

EVOLUTIONARY DIVERGENCE OF ONUPHID POLYCHAETES ...Environment Resistance, Environmental Physiology, Invertebrate Nutrition, Lugworms, Marine Segmentedworm, Water Temperature-non-specific, ...5.0663

ENDOCRINE REGULATED PROCESSES IN TELEOST FISHES ...Environment Resistance, Fish -other, Hypophysectomy, Osmoregulation, Pituitary, ...5.0288

SONIC SENSITIVITY OF FISHES AND AMPHIBIA ...Auditory, Fish -non-specific, Frogs, Sensory Organs, ...5.0960

REPRODUCTIVE ISOLATING MECHANISMS IN PANAMANIAN INSHORE MARINE FISHES ...Behavioral Ecology, Fish -non-specific, Panama, Reproduction Studies (general), ...5.0244

RENIN AND EURYHALINITY ...Histochemistry - Cytochem, Kidney and Urinary System, Osmoregulation, Renin, Vertebrates -non-specific, ...5.0973

Serology and Immunology

IMMUNE MECHANISMS AND RESISTANCE FACTORS IN MARINE FISHES ...Antigen, Fish -other, Histochemical Test, ...5.0255

THE COMPARATIVE IMMUNOLOGY OF LOWER ORGANISMS ...Blood Typing Studies, Comparative Physiology, Immumology, ...5.0556

Ecological

STRUCTURE OF THE FISH FAUNA OF A FLORIDA CORAL REEF ...Fish -non-specific, Reefs, Vertical Distribution, ...5.0205

TAXONOMY AND ECOLOGY OF NEARSHORE MARINE OSTRACODA ...Animal Taxonomy, Biofacies, Class Ostracoda, Environmental Ecology, Paleoenvironments, Shrimps - Seed Or Mussel, ...5.0707

LIVING AND FOSSIL ZOOPLANKTON, AND RELATED PROBLEMS OF PALEOLIMNOLOGY ...Aquatic Ecology, Biology, Microfossils, Paleoecology, Zooplankton, ...7.0171

SYSTEMATIC AND DISTRIBUTIONAL STUDY OF DEEP-SEA ECTOPROCTA (BRYOZOA) ...Adaptation, Animal Taxonomy, Bryozoa, Vertical Distribution, ...5.0650

Ethological

THE EVOLUTION AND CAUSATION OF SOCIAL BEHAVIOR IN ANABANTOID FISHES ...Behavior, Fish -other, Reproduction Studies (general), Social Behavior, ...5.0300

BIOLOGY, MORPHOLOGY, AND EVOLUTION OF THE DISK-FISHES OR SHARKSUCKERS ...Animal Taxonomy, Fish -other, Host Specificity, Vertebrate Anatomy, ...5.0250

Genetic

FAMILIAL RELATIONSHIPS IN TELEOST FISHES ...Animal Taxonomy, Comparative Anatomy, Fish -other, Karyotypes, Nomenclature, Classification, ...5.0148

Geologic

CHEMICAL OCEANOGRAPHY ...Biogeochemical Process, Circulation-general, Organics, Rare Earth Studies, Trace Elements, ...1.0129

PHYLOGENETIC RELATIONS OF FOSSIL AND LIVING GYMNOLAEMATES ...Bryozoa, Fouling, Other Bryozoa, Phylogenies, ...5.0665

COMPARATIVE STUDIES OF LATE MESOZOIC AND EARLY CENOZOIC HERPETOFAUNAS ...Amphibians, Cenozoic Era-general, Evolutionary Studies-general, Lizards, Mesozoic Era-general, ...7.0181

EVOLUTION OF PROVINCIAL DISTRIBUTION PATTERNS IN CHEILOSTOME BRYOZOA ...Bryozoa, Order Cheilostomata, Paleontology, Population - Distribution, Tertiary Period, ...7.0173

RESEARCH ON MINERAL STRUCTURE REVEALED BY AN ELECTRON MICROSCOPE ...Comparative Anatomy, Electron Microscopy, Mineralogy, Paleontology, ...7.0062

Other

EVOLUTION OF ALL-FEMALE FISHES ...Female, Gambusia, Molly, Reproduction Studies (general), ...5.0247

Speciation

CYTOLOGICAL CHARACTERISTIC ...Animal Taxonomy, Basic Embryology, Porifera, Structural Functions, ...5.0557

PATTERNS OF SPECIES DIVERSITY - TERTIARY-RECENT ...Cenozoic Era-general, Foraminifera, Geographical Relations, Number Or Density, Population - Distribution, ...5.0564

Taxonomic

Classical

ECOLOGICAL AND EVOLUTIONARY IMPLICATIONS OF THE ECOTYPES OF ESTUARINE CRUSTACEA ...Estuaries, Invertebrate Anatomy, Isopods, Metabolism, Productivity - Food Chain, ...5.0418

SYSTEMATIC REVISION PLATYCEPHALIDAE (PISCES) ...Fish -other, Indian Ocean-general, Museum, Nomenclature, Classification, ...5.0050

Organism Sampling Devices

HYDROGRAPHIC AND BIOLOGICAL SURVEY OF MONTSWEAG BAY AND VICINITY ...Bays, Maine, Number Or Density, Vertical Distribution, Zooplankton, ...5.0893

ECOLOGICAL STUDIES OF RADIOACTIVITY IN THE COLUMBIA RIVER ESTUARY AND ADJACENT PACIFIC OCEAN ...Columbia River, Contamination - Water, Pacific Ocean-north, Pollutants - Path of , Radioactivity-general, ...6.0172

URANIUM GEOCHEMISTRY IN (MODERN) CARBONATES USING THE FISSION TRACK METHOD ...Biogeochemical Process, Carbonates-general, Chemistry, Diagenesis, Uranium, ...7.0076

DEVELOPMENT AND EVALUATION OF A NEW TECHNIQUE FOR SAMPLING ZOOPLANKTON ...Population Dynamics, Productivity - Food Chain, Technique Development, Vertical Distribution, Zooplankton, ...5.0786

MICROZOOPLANKTERS IN THE MARINE FOOD CHAIN ...Population Dynamics, Productivity - Food Chain, Vertical Distribution, Zooplankton, ...5.0748

DISTRIBUTION OF THE MID-WATER FISHES OF THE GULF OF CALIFORNIA ...Environmental Ecology, Fish -non-specific, Gulf of California, Nets, Vertical Distribution, ...5.0043

DEEP-SEA AUTONOMOUS VEHICLES, INSTRUMENTS, BASIC CONTROL DEVICES, AND SPECIAL COLLECTING GEAR ...Abyssal, Bottom Sampling Device, Photography, Sampling, Submersibles, Water Motion Recorders, ...8.0122

BIO-ACOUSTIC AND BIOLOGICAL SAMPLING GEAR STUDIES ...Acoustical, Indian Ocean-general, Mapping, Plankton (non-specific), ...8.0126

MARINE LABORATORY ...Fishing Gear, Laboratory Analysis, Louisiana, Nets, Technique Development, ...11.0024

COOK INLET ESCAPEMENT ENUMERATION STUDY ...Alaska, Censusing, Migration, Salmon -coho,chinook,sockeye.., Sonar, Sonar and Echo Sounding, ...8.0112

BENTHIC MARINE FAUNA OF THE UPPER SHELF OFF VIRGINIA ...Animal Taxonomy, Benthic Fauna, Benthonic-bottom, Continental Shelf, Virginia, ...5.0660

STUDY OF NORTH AND EQUATORIAL ATLANTIC PLANKTONIC FORAMINIFERA ...Foraminifera, Number Or Density, Oceanic Fronts, Vertical Distribution, ...5.0764

PRE-CONSTRUCTION ENVIRONMENTAL SURVEY ...Construction Land Use Effects, Construction Sites, Continental Shelf, Environmental Ecology, Reefs, ...5.0907

DESIGN AND DEVELOPMENT OF NEKTON SAMPLER ...Food Supply, Nektonic - Swimming, Plankton Sampling, Tuna, Mackerel, Albacore... , ...8.0129

PRODUCTIVITY MEASURES ...Number Or Density, Ocean Currents-other, Pacific Ocean-east, Primary Productivity, Productivity - Food Chain, Zooplankton, ...5.0940

Overturn

CHEMISTRY OF THE HYPOLIMNION OF LAKE ERIE ...Chemical-general, Ions and Gases, Lake Erie, Oxygen, Stratification, ...1.0115

Oxide

CATALYSIS AND KINETICS OF MANGANOUS ION OXIDATION IN AQUEOUS SOLUTION AND ADSORBED ON THE SURFACES OF SOLID OXIDES ...Adsorption, Heterogeneous Catalysis, Manganese, Oxidation-other, Precipitates, Solution, ...2.0063

Oxygen

LIGHT ISOTOPE STUDIES ...Chemical Reactions, Circulation-general, Deuterium, Isotope Tracer-other, Mixing, Particle-gas Transfer, ...1.0077

RELATIONSHIP OF PHOTOSYNTHESIS TO RESPIRATION OF OCEANIC MICROALGAE ...Light, Marine Plants, Mass Spectroscopy, Photosynthesis, Respiration, ...5.0774

MEASUREMENTS OF OXYGEN CONSUMPTION BY THE SEA BED IN DEEP WATER OF PUGET SOUND ...Benthic Flora, Chemistry, Oxygen Content -water, Puget Sound, ...5.1036

STABLE ISOTOPE FRACTIONATION IN ECHINODERM CALCITE ...Animal Taxonomy, Biogeochemical Process, Calcite, Carbon, Living Organisms, Marine Organisms, Sea Feathers,sea Lily... , Sea Urchins & Other Echinoderm, ...7.0085

DEVELOPMENT OF AN INSTRUMENT FOR MEASURING THE CONCENTRATION OF DISSOLVED OXYGEN IN SEA WATER IN SITU ...Chemical Analysis (water), Gases, Instrumental Services, Technique Development, Telemetry-other, ...8.0092

STABLE CARBON AND OXYGEN ISOTOPE RATIO VARIATIONS IN THE FLOW TO CARBON AND OXYGEN THROUGH NORMAL AND POLLUTED AQUATIC SYSTEMS ...Carbon, Element Ratios, Organic-general, Pollutants - Path of , Sewerage Systems-other, Water Analysis, ...1.0132

INSTRUMENT DEVELOPMENT ...Navigation, Satellites, Technique Development, ...8.0065

PRECISION MEASUREMENTS OF DISSOLVED OXYGEN, NITROGEN AND ARGON IN SEAWATER ...Argon, Gases, Nitrogen, Particle-gas Transfer, Solubility, Special Mission Ships, ...1.0092

ORGANIC MATTER ...Atlantic Ocean-general, Mixing, Oceanic Fronts, Organics, Sampling, Ships and Cruises, ...1.0111

MICROBIOLOGICAL CONTROL IN NAVY AND MARINE CORPS OPERATING ENVIRONMENTS ...Fouling, Medical Studies, Microorganisms (non-specific), ...5.0740

A STOCHASTIC MODEL FOR POLLUTION IN ESTUARIES ...Estuaries, Ions and Gases, Model Studies, Water Quality Control-general, Water Quality-general, ...6.0188

DEEP SUBMERGENCE DISSOLVED OXYGEN TRANSDUCER ...Gases, Instrumental Services, Submersibles, Transducers, ...8.0057

THE THERMODYNAMIC PROPERTIES OF NITROGEN-OXYGEN MIXTURES ...Critical, Enthalpy, Entropy, Nitrogen, State Equations, Survey Studies, ...8.0025

CARBON DIOXIDE FIXATION IN HETEROTROPHIC ORGANISMS III THE BREAKDOWN OF GLYCOGEN IN MARINE INVERTEBRATES ...Alanine, Carbon Dioxide Fixation, Catabolism and Degradation, Glycogen, Metabolism, ...5.1033

OXYGEN RESOURCES OF TIDAL WATERS ...Autotrophic, Marine Biology (non-specific), Oxygen Content -water, Pollution Sources-general, Tides, ...1.0119

OXYGEN PROPERTIES ...Density, Liquid Propellant Rock, Oxidizers, Specific Heat, State Equations, Thermodynamic Relation, ...8.0174

CHEMISTRY OF THE HYPOLIMNION OF LAKE ERIE ...Chemical-general, Ions and Gases, Lake Erie, Overturn, Stratification, ...1.0115

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON ...Copepods, Water Salinity, Water Temperature-non-specific, Zooplankton, ...5.0835

Pacific Ocean-east

RELATIONSHIPS BETWEEN RATES OF SEDIMENT ACCUMULATION & CHANGES WITH DEPTH OF CERTAIN MASS PHYSICAL PROPERTIES IN MARINE SEDIMENTS ...California, Coring and Dredging, Interstitial - Connate Water, Rate of Deposition, Shear Strength, ...8.0335

CIRCULATION STUDIES ...Circulation-general, Currents-ocean, Gulf of Mexico, Hydrodynamics, Mixing, ...2.0042

DESCRIPTIVE OCEANOGRAPHY ...Circulation-general, Currents-ocean, Data Analysis - General, Wind-water Interaction, ...4.0116

BARNACLES OF THE EASTERN PACIFIC ...Barnacles, Life History Studies, ...5.0515

RESTORATION, PROPAGATION, AND MANAGEMENT OF MARINE ALGAE ...Applied Ecology, Growth and Differentiation, Habitat Studies, Laminariaceae (non-specif.&ot), Marine Plants, ...5.0680

COLLECTION AND INTERPRETATION OF OCEANIC THERMAL GRADIENTS ...Bathythermographs, Gulf of Mexico, Heat Flow Measurements, Temperature, ...1.0187

THE POSTPLEISTOCENE OCEANOGRAPHY AND BIOLOGY OF THE EASTERN NORTH PACIFIC ...Climatography, Marine Biology, Ocean History, Pacific Ocean-north, ...7.0158

RESEARCH VESSEL OPERATIONS ...Continental Shelves, Facilities, Oceanography-general, Oregon, Ships and Cruises, ...12.0041

PETROLOGY AND GEOCHEMISTRY OF IGNEOUS ROCKS FROM THE OCEAN FLOOR ...Argon-potassium, Extrusives, Petrography, Petrology, Ridges, Sima, ...7.0064

DEEP OCEAN AS RECIPIENT OF VOLATILES AND SOLUTES ...Hydrothermal Minerals, Igneous Activity - Volcanism, Lithology, Ridges, Sea Floor Spreading, Thermal Features, Water Analysis-general, ...7.0095

OCEAN BOTTOM EMPLACED GEOPHYSICAL STATION ...Automatic Stations, Benthonic-bottom, Dynamic Gravimeters, Geophysical Equipment, Gravity Studies, Instrumental Services, Temperature, Water Motion Recorders, ...4.0035

CORING OF THE VARVED SEDIMENTS IN SAANICH INLET ...Canada, Coring and Dredging, Geochronology-general, Local Stratigraphy, Varves, ...7.0282

DIRECT AND INDIRECT DETERMINATION OF OCEANIC WATER MASS MOTION ON ALL SCALES ...Buoys, Currents-ocean, Oceanic Fronts, Salinity, Temperature, ...2.0092

HEAT AND MOMENTUM EXCHANGE PROCESSES BETWEEN THE OCEAN AND THE ATMOSPHERE ...General Synoptic Observations, Heat and Radiation Transfer, Meteorological Studies, Oregon, Wind-water Interaction, ...3.0038

CHEMICAL PROPERTIES OF SEA WATER AND THEIR USE IN STUDIES OF WATER MASSES AND MIXING ...Chemical Reactions, Gases, Mixing, Oceanic Fronts, Water Analysis, ...1.0126

CHARACTERISTICS, CAUSES, AND PREDICTION OF UPWELLING WATER MASSESS OFF OREGON ...Forecasting-prediction, Mixing, Oceanic Fronts, Oregon, Water Motion Recorders, ...2.0062

PELAGIC SHARKS OFF SOUTHERN CALIFORNIA ...Environmental Ecology, Population Dynamics, Sharks, Vertical Distribution, ...5.0196

PROPERTIES AND ORIGIN OF SEDIMENTS IN THE NORTHEAST PACIFIC OCEAN ...Carbon-14, Core Analysis, Origin, Physical Properties, Washington, ...7.0287

OCEANOGRAPHIC PROCESSES IN ESTUARINE AND COASTAL WATERS ...Oceanic Fronts, Puget Sound, Shoreline - Coastline, Washington, Water Properties-general, ...4.0050

CHEMICAL STUDIES OF THE OCEANIC ENVIRONMENT ...Chemical Reactions, Marine Biology, Mixing, Oceanic Fronts, Trace Elements, Water Analysis-general, ...1.0136

DESCRIPTIVE OCEANOGRAPHY/PACIFIC ...Buoys, Circulation-general, Currents-ocean, Wind-water Interaction, ...2.0009

OYSTER SEED PROPAGATION STUDY ...Aquatic Ecology, Bays, Commercial Fishing, Oysters, Spawning & Nesting Sites, ...8.0012

SEDIMENTOLOGY AND GEOLOGIC HISTORY OF HUMBOLDT BAY, CALIFORNIA ...Bays, California, Coring and Dredging, Geologic History-general, Physical Properties, ...7.0193

THE EPICARIDEA OF THE EASTERN PACIFIC ...Animal Taxonomy, Isopods, ...5.0353

SEA USE ...General Synoptic Observations, Marine Biology, Oceanography-general, Platforms, Seamounts-guyots, ...7.0303

STOMATOPOD CRUSTACEA OF THE EASTERN PACIFIC REGION ...Animal Taxonomy, Atlantic Ocean-general, Shrimps - Mantis... , ...5.0397

TAXONOMIC STUDIES ...Animal Taxonomy, Fish -other, Nomenclature, Classification, ...5.0034

BOTTOMFISH EXPLORATIONS ...Commercial Fishing, Fish - other, Nets, Vertical Distribution, ...5.0168

FISHERY FORECASTING - TEMPERATE FISHERIES ...Circulation-general, General Synoptic Observations, Low Temp. -but Above 32f, Temperature, ...5.0197

146 D EASTROPAC ...Marine Biology, Meteorological Studies, Tropic, Tuna, Mackerel, Albacore... , Vertical Distribution, ...4.0113

PRODUCTIVITY MEASURES ...Number Or Density, Ocean Currents-other, Organism Sampling Devices, Primary Productivity, Productivity - Food Chain, Zooplankton, ...5.0940

CALIFORNIA CURRENT SURVEYS ...California Current, Environmental Ecology, Fish -non-specific, Plankton (non-specific), ...4.0114

SCRIPPS TUNA OCEANOGRAPHY RESEARCH PROGRAM ...Food Supply, Temperature, Tropic, Tuna, Mackerel, Albacore... , Water Temperature-non-specific, ...5.0200

MULTISPECIES FISHERIES MODELS ...California, Commercial Fishing, Economics, Model Studies, Oceanic - Pelagic, Production & Processing, ...4.0065

EASTERN TROPICAL PACIFIC COOPERATIVE SURVEY ...Bathythermographs, Mapping, Ships and Cruises, ...4.0122

Pacific Ocean-general

IMPROVEMENT AND APPLICATION OF BENTHIC ALGAL ISOTOPE PRODUCTIVITY MEASURING METHODS ...Algae- General, Benthonic-bottom, Caulerpa, Physiological Ecology, Plant Prod. (non-specific), Rhodophyta (non-specific & Ot), ...5.0968

A STUDY OF THE DEEP CIRCULATION AND DEEP FISH POPULATIONS IN THE PACIFIC OCEAN ...Currents-ocean, Fish -non-specific, Tides, Vertical Distribution, ...2.0005

WATER WAVE DOCUMENTATION ...Buoys, California, Water Motion Recorders, Waves, ...2.0094

EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC ...Animal Toxins, Marine Biology (non-specific), Toxic Substances -non-specific, Toxicological and Allergy, ...6.0109

MAGNETICS ...Anomalies, Atlantic Ocean-north, Ridges, Sea Floor Spreading, Trenches, ...7.0135

CIRCULATION OF THE PACIFIC ...Circulation-general, Density, Oceanic Fronts, Sampling, Subsurface Environments, ...2.0007

RADIOLARIA IN SEDIMENTS ...Biogenous, Core Analysis, Order Radiolaria, Population - Distribution, Tertiary Period, ...7.0160

DISTRIBUTION AND BIOLOGY OF PACIFIC ZOOPLANKTON ...Animal Taxonomy, Productivity - Food Chain, Range Or Territorial Distr. , Vertical Distribution, Zooplankton, ...5.0745

TREMATODES OF FISHES OCCURRING ON THE WEST COAST OF NORTH AMERICA. ...Collections, Comparative Physiology, Nearctic, Trematoda -other, ...5.0636

MARINE PHYTOPLANKTON RESEARCH ...Algal Culture, Indian Ocean-general, Nutrition Studies, Phytoplankton, Symbiosis, ...5.0847

STUDIES OF THE EFFECTS OF NUTRIENTS ON THE GROWTH OF PHYTOPLANKTON IN THE TROPICAL PAC. OCEAN ...Algal Culture, Growth Rate, Nutrition, Phytoplankton, Tropic, ...5.0948

BIOCHEMICAL BASIS OF SPECIFIC CELL ASSOCIATION ...Adhesion, Basic Embryology, Chickens, Porifera, ...5.0946

MODERN FORAMINIFERA OFF OREGON ...Continental Shelf, Foraminifera, Oregon, Vertical Distribution, ...5.0820

DEEP FLOW, WATER CHARACTERISTICS, TOPOGRAPHY AND SEDIMENTS IN THE CENTRAL PACIFIC AREA ...Abyssal, Currents-bottom, Distribution, Geomorphology-topography, Structural Studies, Water Motion Recorders, ...7.0032

REFLECTION PROFILING OF THE SEA FLOOR ...Atolls, Continental Shelves, Fault Complexes, Geomorphology-topography, Seismic Reflection, ...7.0091

STUDY OF DEEP PACIFIC CIRCULATION USING SILICON-32 ...Carbon, Circulation-general, General Sea Water Chemistry, Silicon, Tracers, ...2.0006

GEOLOGIC HISTORY OF PACIFIC FAUNAS ...Evolutionary Studies-general, Geochronology-general, Paleoecology, Paleontology, Sea Level Changes, ...7.0156

ATMOSPHERIC EFFECTS ON INCOMING SOLAR RADIATION OVER TROPICAL OCEANS ...Cloud Cover, Development of Models, Humidity, Sunshine, Tropic, ...3.0036

NATURAL RADIOCARBON MEASUREMENTS ...Carbon-14, Facilities, Mixing, Oceanic Fronts, Radioactivity, ...1.0084

EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC ...Animal Toxins, Toxicological and Allergy, Toxicology, ...6.0110

STUDIES ON THE SPORT FISHERY FOR BILLFISHES AND TUNAS IN THE WESTERN ATLANTIC AND SOUTHEASTERN PACIFIC OCEAN. ...Atlantic Ocean-general, Fishing, Swordfish, Tuna, Mackerel, Albacore... , ...5.0069

STUDY ON THE DISTRIBUTION AND ABUNDANCE OF PINK SHRIMP, PANDALUS JORDANI, IN THE PACIFIC OCEAN OFF OREGON ...Censusing, Fishing Gear, Life History Studies, Population Dynamics, Shrimps - Common, ...5.0487

PRELIMINARY STUDY TO DETERMINE ABUNDANCE AND RECRUITMENT OF BOTTOMFISH OFF OREGON ...Nets, Number Or Density, Oregon, Righteye Flounders, ...5.0136

FOOD HABITS STUDY OF ORGANISMS OF THE CALIFORNIA CURRENT SYSTEM ...Behavioral Ecology, California, California Current, Food Supply, ...5.0044

PACIFIC OCEAN INFLUENCE UPON CALIFORNIA RAINFALL ...California, Forecasting, Patterns, Rain-other, Temperature, ...3.0057

CHRONOLOGY OF MARINE SEDIMENTS, CIRCULATION OF WATER AND TRACE ELEMENTS, SEDIMENTARY RECORD AND EXTRATERRESTRIAL ACCRETION ...Circulation-general, Cosmogenous, Paleoclimatology, Sedimentary History, Trace Elements, ...1.0098

PACIFIC OCEAN BIOLOGICAL SURVEY PROGRAM ...Birds - non-specific, Islands, Meteorological Studies, Vertical Distribution, ...5.0568

TAGGING PROGRAM WITH WOODS HOLE AND INTERNATIONAL GAME FISH ASSOCIATION FOR MARLIN, SAILFISH AND OTHER GAME SPECIES MIGRATION STUDIES ...Marlin, Billfishes, Sailfish.., Migration, Population Dynamics, Tags, ...5.0036

MARINE INVERTEBRATE EXPLORATIONS ...Commercial Fishing, Freshwater Mussels, Scallops, Shrimps - Common, Temporal Distribution, Vertical Distribution, ...5.0733

INVESTIGATE FACTORS DETERMING DISTRIBUTION OF PHYSICAL AND CHEMICAL PROPERTIES OF THE PACIFIC OCEAN ...Currents-ocean, Hawaii, Mathematical Analysis, Model Studies, Oceanic Fronts, ...5.0888

ANALYZE AND PUBLISH BASIC DATA FROM PILOT STUDY ...Environmental Changes, Oceanic Fronts, Salinity, Technique Development, Thermal, ...4.0024

IDENTIFICATION OF SOCKEYE SALMON STOCKS BY BONE MINERALS ...Animal Taxonomy, Bone, Chemical Analysis, Salmon -coho,chinook,sockeye.., ...5.0333

EASTERN PACIFIC SHRIMPS OF THE GENUS PENAEUS ...Animal Taxonomy, Life History Studies, Range Or Territorial Distr. , Shrimps - Common, Vertical Distribution, ...5.0403

INVESTIGATE TUNA SUBPOPULATIONS THROUGH THE USE OF BLOOD GROUPS AND INHERITED PROTEINS ...Blood Proteins -non-specific, Blood Typing Studies, Population Dynamics, Tuna, Mackerel, Albacore... , ...5.0076

ASSESSMENT OF CENTRAL PACIFIC TUNA RESOURCES ...Commercial Fishing, Population Dynamics, Size, Tuna, Mackerel, Albacore... , ...5.0082

DEVELOP HIGH-SEAS TUNA FISHERY ...Commercial Fishing, Fishing Gear, Tropic, Tuna, Mackerel, Albacore... , ...5.0084

DEVELOP FISHERIES FOR NON-TUNA RESOURCES ...Commercial Fishing, Fishing Gear, Hawaii, Snappers, ...5.0086

PACIFIC OYSTER MORTALITY STUDIES ...Invertebrate Pathology, Mortality Rates, Oysters, Pathology, ...5.0442

SUBPOPULATIONS ...Anchovies, Commercial Fishing, Population Dynamics, ...5.0042

PACIFIC BIOMEDICAL RESEARCH ...Buildings, Mycobacterium Leprae, Pharmacognosy, ...6.0112

NEW DRUGS FROM THE SEA, ESPECIALLY ANTIBIOTICS ...Antibiotics, Caribbean Sea, Marine Plants, ...6.0123

MARINE TOXINS OF THE TROPICAL PACIFIC ...Algal Metab.(non-specific &ot), Fish -non-specific, Polynesia, Toxicology, Toxins, ...6.0113

Pacific Ocean-north

STUDY OF THE DISTRIBUTION OF RADIONUCLIDES IN THE OCEAN DETAILED EXPLORATION OF CS137 IN THE OCEAN ...Cesium, Chemical Analysis (water), Circulation-general, Convection, Radioactivity, ...1.0080

ECOLOGICAL STUDIES OF RADIOACTIVITY IN THE COLUMBIA RIVER ESTUARY AND ADJACENT PACIFIC OCEAN ...Columbia River, Contamination - Water, Organism Sampling Devices, Pollutants - Path of , Radioactivity-general, ...6.0172

PACIFIC GRAVITY ...Anomalies, Crust, Earth Interior, Geophysical Equipment, Gravity Studies, ...7.0144

CONVECTIVE STUDIES ...Convection, Sonar, Thermal, ...2.0011

WAVES ...Thermal, Waves, Waves-internal, ...2.0097

MOHOLE SITE STUDIES ...Coring and Dredging, Earth Interior, Hawaii, Seismic Studies, Structure Location, ...7.0097

THE POSTPLEISTOCENE OCEANOGRAPHY AND BIOLOGY OF THE EASTERN NORTH PACIFIC ...Climatography, Marine Biology, Ocean History, Pacific Ocean-east, ...7.0158

THE CONTRIBUTION OF ADVECTION AND LOCAL HEATING TO THE MAINTENANCE OF THE THERMAL STRUCTURE IN THE NORTH PACIFIC OCEAN ...Circulation-general, Convection, Heat and Radiation Transfer, Mixing, Thermal, ...1.0183

STUDY OF RADIOLARIA IN SURFACE SEDIMENTS OF THE NORTHEAST PACIFIC OCEAN ...Animal Taxonomy, Biogenous, Protozoa -other, Vertical Distribution, ...7.0187

LENGTHENING AND INCREASING OCEANOGRAPHIC CAPABILITES OF R/V ACONA ...Equipment Purchase Operation, Modification-conversion, Oceanography-general, Shoreline - Coastline, Special Mission Ships, ...12.0002

A PALEOMAGNETIC STUDY OF TERTIARY AND PLEISTOCENE OCEANIC CORES ...Antarctic Ocean, Core Analysis, Field Reversals, Paleomagnetism, Quaternary Period, Tertiary Period, ...7.0166

OCEANOGRAPHIC VESSEL OPERATIONS ...Equipment Purchase Operation, Geology-general, Plankton (non-specific), Plant Prod. (non-specific), Ships and Cruises, ...12.0047

CHEMICAL FEATURES OF THE SUBARCTIC BOUNDARY IN THE NORTHERN PACIFIC OCEAN ...Carbon Dioxide, Circulation-general, Gases, Mixing, Oceanic Fronts, Sub - Polar, ...1.0125

RADIOLARIA IN PACIFIC SEDIMENTS ...Arctic, Biogenous, Classification - Taxonomy, Order Radiolaria, Population - Distribution, ...7.0284

UNDERWATER CAMERA SYSTEM ...Equipment Purchase Operation, Photography, Sediments-general, Structural Studies, ...8.0154

SEDIMENT AND VOLCANIC STUDIES ...Distribution, Origin, Sedimentary Petrology, Stratigraphy-general, Volcanic, ...7.0189

DEEP SEA SEDIMENTS IN THE NORTH PACIFIC FROM STUDIES OF THEIR RADIOLARIAN CONTENT ...Biogenous, Core Analysis, Distribution, Protozoa -other, Sedimentation, ...7.0285

FINE STRUCTURE FEATURES OF TEMPERATURE AND SALINITY AT WATER MASS BOUNDARIES IN PACIFIC ...Circulation-general, Mixing, Oceanic Fronts, Salinity, Temperature, ...2.0046

LARGE-SCALE INTERACTIONS ...Acoustical, Air-sea Boundary-general, Buoys, Temperature, Thermal, ...3.0006

INTRODUCTION OF MARINE GAME FISHES FROM AREAS IN THE PACIFIC ...Diving and Scuba, Hawaii, Stocking of Fish & Shellfish, ...5.0075

ECONOMICS OF MARKETING DUNGENES CRAB ...Crabs, Marketing, Price & Value, ...5.0484

PHYSICAL AND RADIOLOGICAL CHEMISTRY OF OCEAN SOLUTIONS ...Chemical Reactions, Octopus, Squid, Cuttlefish... , Radioactive Fallout, Radioactivity-general, Tracers, ...1.0133

UPGRADING CONVENTIONAL FISHING TECHNIQUES ...Commercial Fishing, Fishing Gear, Nets, Sonar, Telemetry, ...8.0150

HISTORICAL CHARTS AND INTERPRETATION OF CHANGES IN SEA SURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN ...Air-sea Boundary-general, Atlases-maps, Circulation-general, Commercial Fishing, Temperature, ...1.0179

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EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...Estuaries, Mode of Action -animal, Model Studies, Pollution - Effects of , Sevin, ...**5.0919**

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RATE OF ABSORPTION OF ENDRIN BY BLUEGILL SUNFISH ...Bioassay, Bluegills, Bream, DDT , Metabolism, Mode of Action -animal, ...**5.0263**

PESTICIDE RESISTANT FISH IN NATURAL ECOSYSTEMS ...Animal Resistance -other, Fish, Food Chains, Animal And/or Man, Pollution Effects, Rates, Doses, Concentrations, ...**5.0277**

Herbicides

Diquat

EFFECT OF EURASIAN WATERMILFOIL CONTROL PROCEDURES ON WILDLIFE AND OTHER ORGANISMS IN AQUATIC ENVIRONMENTS ...Contamination - Water, Evaluation, Water Milfoil, Waterweed... , 2,4-d, ...**5.0700**

Herbicides -non-specific

TOXICANT TOLERANCE STUDIES - SCREENING OF PESTICIDES AND AQUATIC INVERTEBRATES AT TIBURON ...California, Insecticides -non-specific, Laboratory Animals, Screening Potential Pesticides, ...**5.0906**

MESO WIND PATTERNS IN THE CENTRAL CALIFORNIA VALLEY ...Atmospheric Pollution-general, California, Drift (pesticide), Land-sea Breezes, Wind Erosion, ...**3.0056**

2,4-d

EFFECT OF EURASIAN WATERMILFOIL CONTROL PROCEDURES ON WILDLIFE AND OTHER ORGANISMS IN AQUATIC ENVIRONMENTS ...Contamination - Water, Diquat, Evaluation, Water Milfoil, Waterweed... , ...**5.0700**

Insecticides -non-specific

SUPPORT FOR THE PHYSIOLOGICAL RESEARCH SHIP, R/V ALPHA HELIX ...Mycorrhiza, Nerve Effects, Rain Forests, Regulation, Tropic, ...**12.0011**

TOXICANT TOLERANCE STUDIES - SCREENING OF PESTICIDES AND AQUATIC INVERTEBRATES AT TIBURON ...California, Herbicides -non-specific, Laboratory Animals, Screening Potential Pesticides, ...**5.0906**

MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES ...Fish -non-specific, Great Lakes-general, Monitoring Systems, Pollutants-general, Sampling, ...**6.0120**

RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...Fish, Lake Michigan, Lake Superior, Lake Trout, Brook Trout, Pollution Effects, Salmon -coho,chinook,sockeye.., ...**6.0154**

MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ORGANISMS ...Chlorinated Hydrocarbons, Food Chains, Animal And/or Man, Pollution Effects, Productivity - Food Chain, ...**6.0155**

PESTICIDE KINETICS ...Aquatic Or Soil-aquatic Cycles, Degradation, Estuaries, Marine Biology (non-specific), Pollutants - Path of , ...**6.0148**

Pesticides -non-specific

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...Aquatic Ecology, Estuaries, Mans Activities, Persistance of Residues, Pollution - Effects of , Population Dynamics, Standing Crops, ...**5.0880**

IMPACT AND FATE OF POLLUTION IN ESTUARIAL WATERS ...Degradation, Estuaries, Massachusetts, Pollutants - Path of , Pollution Effects, ...**6.0153**

EXPLORATORY COLLECTION AND CARE OF AQUATIC INVERTEBRATES FOR TESTING AT TIBURON ...Bioassay, Brackish Water, Captive Rearing, Invertebrates -non-specific, ...**5.0905**

TOXICANT TOLERANCE STUDIES-SCREENING OF PESTICIDES AND FISH AT TIBURON ...California, Fish -non-specific, Laboratory Animals, Screening Potential Pesticides, ...**5.0278**

PESTICIDES ...Aquatic Or Soil-aquatic Cycles, Bioassay, Fish, Persistance of Residues, Pollution Effects, ...**5.0881**

ARTIFICIAL SELECTION - FISH ...Female Gametes, Fish -non-specific, Genetic Resistance, Pollution - Effects of , Selection & Breeding, ...**5.0256**

Petroleum Cpds. -non-specific

EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE ...Creosote, Fouling, Isopods, Preservatives, Wax, Paraffin, Wood Preservatives-non-specif, ...**8.0198**

Piscicides

Piscicides -non-specific

BIOASSAY ...Animal Pollutant Sources, Evaluation, Lampreys, Streams, Water Properties-general, ...**5.0632**

Sevin

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...Bioassay, Estuaries, Persistance of Residues, Pollution - Effects of , Swamps-marshes, ...**5.0918**

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...Dursban, Estuaries, Mode of Action -animal, Model Studies, Pollution - Effects of , ...**5.0919**

Pesticides

Wood Preservatives

Creosote

MOBILITY OF OIL-TYPE PRESERVATIVES IN IMMERSED WOOD ...Evaluation, Forestry, Liquid - Solid Interactions, Marine Biology (non-specific), Wood Preservatives-non-specif, ...8.0238

EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE ...Fouling, Isopods, Petroleum Cpds. -non-specific, Preservatives, Wax, Paraffin, Wood Preservatives-non-specif, ...8.0198

Wood Preservatives-non-specif.

MICROBIOLOGICAL INVESTIGATIONS OF THRESHOLD PANELS ...Catabolism and Degradation, Degradation, Freshwater Mussels, Scallops, Marine Bacteria, Marine Fungi (non-specific), Wood, ...8.0243

MOBILITY OF OIL-TYPE PRESERVATIVES IN IMMERSED WOOD ...Creosote, Evaluation, Forestry, Liquid - Solid Interactions, Marine Biology (non-specific), ...8.0238

CHEMICAL WOOD PRESERVATIVE TREATMENTS ...Biological, Corrosion Prevention-other, Creosote, Fouling, ...8.0197

EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE ...Creosote, Fouling, Isopods, Petroleum Cpds. -non-specific, Preservatives, Wax, Paraffin, ...8.0198

Petrography

THE FORMATION OF DOLOSTONE AND CHERT IN THE UPPER MIDDLE CAMBRIAN OF THE GREAT BASIN ...Cambrian Period, Chert, Diagenesis, Dolomite, Great Basin, ...7.0283

GEOMICROBIOLOGICAL WEATHERING PHENOMENA OFF ANVERS ISLAND ...Antarctica, Habitat Studies, Identification, Marine Bacteria, Weathering, ...7.0232

PETROLOGY AND GEOCHEMISTRY OF IGNEOUS ROCKS FROM THE OCEAN FLOOR ...Argon-potassium, Extrusives, Pacific Ocean-east, Petrology, Ridges, Sima, ...7.0064

Petrology

SUPPORT OF RESEARCH VESSELS JOHN ELLIOTT PILLSBURY, GERDA, TURSIOPS ...Microfossils, Mineralogy, Paleotemperature, Seismic Studies, Ships and Cruises, ...12.0024

ANALYSES OF ROCKS COLLECTED IN THE INDIAN AND ATLANTIC OCEANS ...Atlantic Ocean-general, Crust, Indian Ocean-general, Ocean Basins, Structural Studies, ...7.0073

THE MARINE GEOLOGY OF THE SOUTHERN OCEAN ...Antarctic Ocean, Chemistry, Coring and Dredging, Distribution, Mineralogy, ...7.0067

MARINE GEOLOGY OF THE SUB-ANTARCTIC PACIFIC REGION ...Antarctic Ocean, Core Analysis, Diagenesis, Distribution, Origin, Sedimentary History, ...7.0049

ISOTOPIC AND TRACE ELEMENT STUDIES IN OCEANIC VOLCANIC ROCKS ...Igneous Rocks, Lead, Magma, Magmas, Rare Earth Studies, Strontium, Trace Element Analysis, Volcanic, ...7.0075

PETROLOGY AND GEOCHEMISTRY OF IGNEOUS ROCKS FROM THE OCEAN FLOOR ...Argon-potassium, Extrusives, Pacific Ocean-east, Petrography, Ridges, Sima, ...7.0064

CONTRACT FOR-PROCESSING OF USARP ROCK SAMPLES ...Antarctica, Classifications, Collections, Coring and Dredging, Sampling, Ships and Cruises, Thin Sections, ...7.0060

UPPER MANTLE OF OCEAN REGIONS ...Earth Interior, Extrusives, High Pressure Research, High Temperature Research, Lava, Ridges, ...7.0053

SEA-FLOOR SEDIMENTS AND ROCK STUDIES ...Atlantic Ocean-north, Biogenous, Core Analysis, Microfossils, Paleomagnetism, Ridges, Sedimentation, ...7.0040

IGNEOUS AND SEDIMENTARY ROCKS FROM THE NORTH WALL OF THE PUERTO RICO TRENCH ...Igneous Rocks, Puerto Rico, Sedimentary Rocks, Trenches, ...7.0083

ROCKS OF OCEANIC CRUST AND UPPER MANTLE EQUATORIAL ATLANTIC ...Atlantic Ocean-general, Crust, Earth Interior, Ocean Basins, Petrogenesis-general, Stability Fields, ...7.0059

ROCKS OF THE OCEANIC CRUST ...Basins, Ocean Basins, ...7.0061

WESTERN PACIFIC ISLANDS ...Hawaii, Igneous Activity - Volcanism, Lava, Mapping, Sea Level Changes, ...7.0104

PRELIMINARY STUDIES TO CORRELATE SELECTED MINERALOGIC AND GEOLOGIC PROPERTIES WITH ENGINEERING PROPERTIES ...Alaska, Engineering Geology, Mineralogy, Ships and Cruises, Trace Element Analysis, ...8.0169

Igneous Rocks

IGNEOUS AND SEDIMENTARY ROCKS FROM THE NORTH WALL OF THE PUERTO RICO TRENCH ...Petrology, Puerto Rico, Sedimentary Rocks, Trenches, ...7.0083

Crystalline

HIGH PRESSURE ROCK STUDIES ...Attenuation, High Pressure Research, High Temperature Research, Rock Mechanics, ...8.0336

Extrusives

SIGNIFICANCE OF FLUORIDE VARIATIONS IN SEA WATER ...Atlantic Ocean-general, Chloride, Element Ratios, Fluoride, Water Analysis-general, ...1.0105

PETROLOGY AND GEOCHEMISTRY OF IGNEOUS ROCKS FROM THE OCEAN FLOOR ...Argon-potassium, Pacific Ocean-east, Petrography, Petrology, Ridges, Sima, ...7.0064

THE MAGNETIZATION OF SUBMARINE BASALTS AND ITS EFFECT ON MARINE MAGNETIC ANOMALIES ...Anomalies, Field Reversals, Magnetic Studies, Paleomagnetism, Seamounts-guyots, ...7.0153

UPPER MANTLE OF OCEAN REGIONS ...Earth Interior, High Pressure Research, High Temperature Research, Lava, Petrology, Ridges, ...7.0053

ALPINE LIMNOLOGY PROJECT ...Core Analysis, Dust - Particulate Matter, Hawaii, Lakes, Mountains-alpine, Volcanoes, ...7.0236

CORRELATION OF SUBMARINE VOLCANIC ASH BY CATHODO-LUMINESCENCE ...Correlation, Geochronology-general, Luminescence, Qualitative, Size, ...7.0255

AGE RELATIONS OF IGNEOUS ROCKS FROM THE MID-ATLANTIC RIDGE ...Foliated Rocks, Geologic Age Relations, Rare Earth Studies, Ridges, Trace Element Analysis, ...7.0080

Lava

UPPER MANTLE OF OCEAN REGIONS ...Earth Interior, Extrusives, High Pressure Research, High Temperature Research, Petrology, Ridges, ...7.0053

WESTERN PACIFIC ISLANDS ...Hawaii, Igneous Activity - Volcanism, Mapping, Petrology, Sea Level Changes, ...7.0104

Magma

ISOTOPIC AND TRACE ELEMENT STUDIES IN OCEANIC VOLCANIC ROCKS ...Igneous Rocks, Lead, Magmas, Petrology, Rare Earth Studies, Strontium, Trace Element Analysis, Volcanic, ...7.0075

Plutonic

GEOLOGIC INVESTIGATIONS IN PUERTO RICO & THE CARIBBEAN ...Caribbean Sea, Element Ratios, Puerto Rico, Sedimentary Petrology, Volcanic, ...7.0042

Sima

PETROLOGY AND GEOCHEMISTRY OF IGNEOUS ROCKS FROM THE OCEAN FLOOR ...Argon-potassium, Extrusives, Pacific Ocean-east, Petrography, Petrology, Ridges, ...7.0064

Volcanic

AZORES VOLCANIC STUDY ...Atlantic Ocean-general, Azores, Element Ratios, Igneous Activity - Volcanism, Ridges, ...8.0195

ISOTOPIC AND TRACE ELEMENT STUDIES IN OCEANIC VOLCANIC ROCKS ...Igneous Rocks, Lead, Magma, Magmas, Petrology, Rare Earth Studies, Strontium, Trace Element Analysis, ...7.0075

SEDIMENT AND VOLCANIC STUDIES ...Distribution, Origin, Pacific Ocean-north, Sedimentary Petrology, Stratigraphy-general, ...7.0189

GEOLOGIC INVESTIGATIONS IN PUERTO RICO & THE CARIBBEAN ...Caribbean Sea, Element Ratios, Plutonic, Puerto Rico, Sedimentary Petrology, ...7.0042

Metamorphic Rocks

Foliated Rocks

AGE RELATIONS OF IGNEOUS ROCKS FROM THE MID-ATLANTIC RIDGE ...Extrusives, Geologic Age Relations, Rare Earth Studies, Ridges, Trace Element Analysis, ...7.0080

Petrogenesis

Igneous Rocks

ISOTOPIC AND TRACE ELEMENT STUDIES IN OCEANIC VOLCANIC ROCKS ...Lead, Magma, Magmas, Petrology, Rare Earth Studies, Strontium, Trace Element Analysis, Volcanic, ...7.0075

Petrogenesis-general

ROCKS OF OCEANIC CRUST AND UPPER MANTLE EQUATORIAL ATLANTIC ...Atlantic Ocean-general, Crust, Earth Interior, Ocean Basins, Petrology, Stability Fields, ...7.0059

Pharmacology

Chemistry

RESEARCH AND GRADUATE TRAINING IN FOOD AND DRUGS FROM THE SEA, AND MARINE POLLUTION ...Antimicrobial, Carcinostatic, Fish Protein Concentrate, Pollution Sources-general, Training Grants, Fellowships, ...6.0060

Dynamics

Mechanism of Action

CHARACTERIZATION AND MODE OF ACTION OF PROTEIN VENOMS OF MARINE ANIMALS ...Lecithin, Sea Urchins & Other Echinoderm, Toxicology, Toxins, Venom, ...6.0102

RESEARCH STUDIES IN MOLECULAR PHARMACOLOGY ...Anesthetic, Bonding and Binding, Diving and Scuba, Permeability, Thermodynamics, ...6.0100

Group-action

Anesthetic

RESEARCH STUDIES IN MOLECULAR PHARMACOLOGY ...Bonding and Binding, Diving and Scuba, Mechanism of Action, Permeability, Thermodynamics, ...6.0100

Antimicrobial

RESEARCH AND GRADUATE TRAINING IN FOOD AND DRUGS FROM THE SEA, AND MARINE POLLUTION ...Carcinostatic, Chemistry, Fish Protein Concentrate, Pollution Sources-general, Training Grants, Fellowships, ...6.0060

STUDIES ON PHARMACOLOGICALLY ACTIVE COMPOUNDS DERIVED FROM MARINE ORGANISMS ...Carcinostatic, Metabolic Agent, Neuroeffective, Pharmacognosy, ...6.0122

Carcinostatic

RESEARCH AND GRADUATE TRAINING IN FOOD AND DRUGS FROM THE SEA, AND MARINE POLLUTION ...Antimicrobial, Chemistry, Fish Protein Concentrate, Pollution Sources-general, Training Grants, Fellowships, ...6.0060

STUDIES ON PHARMACOLOGICALLY ACTIVE COMPOUNDS DERIVED FROM MARINE ORGANISMS ...Antimicrobial, Metabolic Agent, Neuroeffective, Pharmacognosy, ...6.0122

Metabolic Agent

STUDIES ON PHARMACOLOGICALLY ACTIVE COMPOUNDS DERIVED FROM MARINE ORGANISMS ...Antimicrobial, Carcinostatic, Neuroeffective, Pharmacognosy, ...6.0122

Neuroeffective

THE EFFECT OF SOME NEUROTRAMSMITTERS ON THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Brain, Cardiovascular, Horseshoe Or King Crabs, Nerve Effects, ...5.0470

STUDIES ON PHARMACOLOGICALLY ACTIVE COMPOUNDS DERIVED FROM MARINE ORGANISMS ...Antimicrobial, Carcinostatic, Metabolic Agent, Pharmacognosy, ...6.0122

ELASMOBRANCH PHARMACOLOGY ...Drug Evaluation, Mechanism of Action, Sharks, ...6.0118

Vasomotor

STUDIES ON VIBRIO FOOD POISONING ...Bacteria, Bacterial Endotoxins, Food (epidemiology), Microbiological, Toxicological and Allergy, ...6.0114

Pharmacognosy

STUDIES ON PHARMACOLOGICALLY ACTIVE COMPOUNDS DERIVED FROM MARINE ORGANISMS ...Antimicrobial, Carcinostatic, Metabolic Agent, Neuroeffective, ...6.0122

PACIFIC BIOMEDICAL RESEARCH ...Buildings, Mycobacterium Leprae, Pacific Ocean-general, ...6.0112

Toxicology

CHARACTERIZATION AND MODE OF ACTION OF PROTEIN VENOMS OF MARINE ANIMALS ...Lecithin, Mechanism of Action, Sea Urchins & Other Echinoderm, Toxins, Venom, ...6.0102

PHYSALIA TOXIN AND THE ACTIVITY OF BIOLOGICAL MEMBRANES ...Active Transport, Animal Toxins, Cellular Membranes (non-spec.), Jelly Fish, ...6.0107

PHARMACOLOGY AND CHEMISTRY OF TOXIC MARINE ANIMALS ...Animal Toxins, Female Gametes, Sculpins, ...6.0104

EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC ...Animal Toxins, Pacific Ocean-general, Toxicological and Allergy, ...6.0110

ACTIVE CHEMICAL PRINCIPLES DERIVED FROM ECHINODERMS ...Chemoreceptors, Holothurin, Marine Plants, ...6.0117

DEVELOPMENT OF A METHOD FOR CHRONIC TOXICITY BIOASSAY USING MARINE PLANKTONIC ALGAE ...Algal Culture, Bioassays, Marine Plants, Microbiological Analysis, Monitoring (long Term Studies), Phytoplankton, Technique Development, ...5.0726

CHEMISTRY AND PHARMACOLOGY OF TETRODOTOXIN ...Organic, Poisons-other, ...6.0105

MARINE TOXINS OF THE TROPICAL PACIFIC ...Algal Metab.(non-specific &ot), Fish -non-specific, Pacific Ocean-general, Polynesia, Toxins, ...6.0113

COMPARATIVE STUDIES OF DINOFLAGELLATE TOXINS ...Algae- Dinoflagellates, Algal Culture, Algal Toxins, Cellular Physiology, ...6.0121

Phenols

ALGAL SUBSTANCES IN THE MARINE FOOD WEB ...Food Chains, Food Webs, Humic Acid, Marine Plants, Phaeophyta (non-specific & Ot), Secretions and Products, ...5.0725

BIOSYNTHESIS OF BROMOPHENOLS IN MARINE INVERTEBRATES ...Acorn Worms, Bioluminescence, Metabolism, ...5.0961

Philippine Sea

HEAT FLOW AND MAGNETICS IN THE PHILIPPINE SEA ...Arcs, Heat Flow Measurements, Magnetic Studies, Sea Floor Spreading, Trenches, ...7.0137

Philippines

HEAT FLOW MEASUREMENTS ...Basins, Heat Flow Measurements, Melanesia, Ridges, Temperature, ...7.0100

PRIMARY PRODUCTIVITY IN PUERTO GALERA BAY, MINDORO, PHILIPPINES ...Bays, Primary Productivity, Productivity - Food Chain, ...5.1025

PARASITES OF PHILIPPINE FISHES ...Animal Distr. (non-specific), Aquatic Ecology, Fish -non-specific, Helminths, ...5.0251

Phosphate, Phosphite

FLUXES OF DISSOLVED GASES AND NUTRIENTS RELATING TO BIOCHEMICAL AND AERATION PROCESSES OFF THE OREGON COAST ...Chemical Analysis (water), Gases, Oregon, Organics, Particle-gas Transfer, ...3.0037

AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE - LABORATORY PROCEDURES ...Colorimetry, Computer Applications, Conductrometry, Management, Nitrogen, Swamps-marshes, ...5.0761

AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE ...Management, Nitrate, Nitrite, Swamps-marshes, Tidewater Areas, Water Properties-general, ...5.0953

Phosphate, Phosphite

RELATIONSHIPS BETWEEN PHOSPHATE AND OTHER CHEMICALS AT THE WATERSUBSTRATE INTERFACE IN WESTERN LAKE ERIE ...Aquatic Soils, Chemical, Chemical-general, Lake Erie, Sediments, ...**7.0078**

SAMPLING CAMPAIGN ON CORONADO BANK, OFF SOUTHERN CALIFORNIA ...Banks, California, Chemistry, Coring and Dredging, Distribution, ...**7.0003**

NUTRIENT REQUIREMENTS OF ALGAE ...Algal Culture, Cyanophyta (non-specific & Ot), Nitrate, Nitrite, Nutrition Studies, ...**5.0706**

Phosphorus

DISSOLVED ORGANIC PHOSPHORUS I[illegible]AL WATERS ...Lower Plants, Phytoplankton, Wa[illegible]s, ...**1.0123**

BIOLOGICAL AND CHEMICAL STUDY OF VIRGINIA'S ESTUARIES ...Estuaries, Nitrogen, Phytoplankton, Population Dynamics, Primary Productivity, Virginia, ...**1.0158**

NUTRIENT ASSIMILATION RATES - FIELD STUDIES ...Estuaries, Nitrogen, Nitrogen Cycle, Nutrients, Tracers-general, ...**5.0990**

STUDIES ON INORGANIC NUTRIENT ASSIMILATION RATES IN ESTUARINE PONDS ...Estuaries, Mineral Content -water, Nitrogen, Nutrients, Self-purification, ...**5.0991**

TIDE MARSH ECOLOGY AND WILDLIFE ...Management, Microorganisms (non-specific), Nitrogen Cycle, Nutrients, Primary Productivity, Swamps-marshes, ...**5.0870**

INTERACTIONS OF MARINE NUTRIENT COMPLEXES ...Iron, Marine Plants, Nutrients, Phytoplankton, Tracers, ...**5.0956**

Photography

GRANT FOR STUDY OF SEA FLOOR CORES AND PHOTOS ...Core Analysis, Coring and Dredging, ...**7.0258**

FEASIBILITY STUDY FOR A GATED-LASER, IMAGE-AMPLIFIER UNDERWATER VISION SYSTEM ...Electric Lighting Systems, Image Converters, Lasers-masers, Optical Devices, Technique Development, ...**8.0108**

VISIBLE REGION INSTRUMENTATION FOR OCEANOGRAPHIC SATELLITES ...Currents-ocean, Geomorphology-topography, Mapping, Satellites, Shoals, ...**8.0088**

OPTICAL MEASUREMENTS ...Benthonic-bottom, Currents-ocean, Optical, Subsurface Environments, ...**1.0170**

SUBMARINE CANYONS ...California, Development, Erosional Features, Geomorphology-topography, Submarine Canyons, ...**7.0295**

DEEP WATER BENTHIC POLYCHAETES ...Benthic Fauna, Biology, Lugworms, Marine Segmentedworm, Vertical Distribution, ...**5.0540**

HOLOGRAPHIC INSTRUMENTATION FOR MARINE PLANKTON STUDIES ...Lasers and Masers, Zooplankton, ...**8.0066**

DEEP-SEA AUTONOMOUS VEHICLES, INSTRUMENTS, BASIC CONTROL DEVICES, AND SPECIAL COLLECTING GEAR ...Abyssal, Bottom Sampling Device, Organism Sampling Devices, Sampling, Submersibles, Water Motion Recorders, ...**8.0122**

ROCK SAMPLING AND GEOPHYSICAL STUDIES IN THE TONGA KERMADEC TRENCH SOUTHWEST PACIFIC ...American Samoa, Coring and Dredging, Equipment Purchase Operation, Pacific Ocean-west, Seismic Reflection, Trenches, ...**7.0093**

ANTARCTIC PHYSICAL OCEANOGRAPHY ...Antarctic Ocean, Currents-ocean, Depth, Salinity, Temperature, ...**4.0133**

COLLECTION, REDUCTION, AND INTERPRETATION OF SEISMOLOGIC AND PHOTOGRAPHIC DATA ...Data Analysis - General, Distribution, Environment, Ocean Basins, Sedimentary History, Sedimentation, Seismic Studies, ...**7.0262**

HEAT FLOW MEASUREMENTS ...Atlantic Ocean-general, Geophysical Equipment, Heat Flow Measurements, Technique Development, Water Motion Recorders, ...**7.0138**

GEOPHYSICAL AND GEOLOGICAL STUDY OF THE DARWIN RISE ...Bathymetry, Coring and Dredging, Geophysics-general, Gravity Studies, Magnetic Studies, Ocean Basins, Pacific Ocean-west, Refraction, Ridges, Seamounts-guyots, ...**7.0112**

UNDERWATER CAMERA SYSTEM ...Equipment Purchase Operation, Pacific Ocean-north, Sediments-general, Structural Studies, ...**8.0154**

DEEP SEA PHOTOGRAPHIC SYSTEM AND A BOX CORER ...Abyssal, Benthonic-bottom, Coring and Dredging, ...**8.0141**

DEVELOPMENT OF A PHOTOGRAPHIC SUIT FOR STEREOPHOTOGRAMMETRIC MAPPING BY SUMBERSIBLE ...Mapping, Navigation, Sonar, Submersibles, Turkey, ...**4.0060**

MULTISPECTRAL SENSING OF COASTAL ENVIRONMENTS ...Aerial Photography, Beaches, Depth, E M Radiation-general, Geomorphology-topography, Shoreline - Coastline, ...**4.0166**

UNDERWATER ACOUSTIC HOLOGRAPHIC DISPLAY ...Acoustical, Detectors, Holography, Instrumental Services, Recognition Systems, ...**8.0137**

UNDERWATER HOLOGRAPHIC IMAGING ...Holography, Imaging, Technique Development, ...**8.0069**

DISTRIBUTION OF LIFE WITH DEPTH ...Continental Shelf, Motion Pictures -non-specific, North Carolina, Vertical Distribution, ...**5.0885**

GEOLOGICAL AND HYDROGRAPHIC STUDY OF THE WILMINGTON SUBMARINE CANYON AND ADJACENT AREAS ...Bottom Sampling Device, Geomorphology-topography, Model Studies, Submarine Canyons, Textures-structures, ...**7.0211**

UNDERWATER GEOLOGY IN THE OSWEGO AREA OF LAKE ONTARIO ...Erosional Features, Erosional Features-general, Geology-general, Lake Ontario, Sedimentary Structures-other, ...**7.0044**

SEA FLOOR STUDIES - TOPOGRAPHY AND SHAPE OF THE SEA FLOOR ...Acoustical, Geomorphology-topography, Sedimentation, ...**7.0293**

GEOLOGICAL OCEANOGRAPHY - PHYSICAL PROPERTIES ...Bearing Capacity, Biology, Chemistry, Physical Properties, Shear Strength, ...**8.0337**

SPACECRAFT OCEANOGRAPHY ...Instrumentation, Instrumentation-general, Management, Satellites, Unmanned Satelite, ...**4.0157**

AIRBORNE REMOTE SENSING OCEANOGRAPHY PROJECT ...Aircraft, Data Acquisition, Instrumental Services, Radar, Satellites, ...**4.0155**

SEDIMENT MOVEMENT AND BOTTOM CONDITIONS IN THE DELAWARE ESTUARY MOUTH AREA ...Bottom Sampling Device, Currents-other, Delaware Bay, Sedimentation, Tides, ...**7.0220**

ANALYSIS AND INTERPRETATION OF DATA FROM GEOPHYSICAL AND PHOTOGRAB SURVEY OF CORONADO BANK, OFF SOUTHERN CALIFORNIA ...California, Ocean Mining, Phosphate, Potential of Deposit, ...**7.0004**

DEVELOPMENT OF NEW FISHING TECHNIQUES ...Commercial Fishing, Diving and Scuba, Fishing Gear, Geomorphology-topography, Mark, Tag Or Capture -other, Telemetry, ...**8.0151**

WEST GREENLAND GLACIER SURVEY ...Glacial Environment, Greenland, Icebergs, Movement, Types, ...**3.0077**

Aerial Photography

OIL LEAKS AND SLICKS ...Aircraft, Oil, Pollutants-other, Satellites, Technique Development, ...**4.0145**

FISHERIES RESOURCES IDENTIFICATION AND ASSESSMENT ...Behavioral Ecology, Commercial Fishing, Fish -non-specific, Optical, Spectral Reflectance, ...**4.0149**

POPULATION DYNAMICS OF ANTARCTIC SEALS ...Antarctica, Migration, Population Dynamics, Seals, ...**5.0634**

DRAINAGE PATTERN DEVELOPMENT ON TIDAL MARSHES ...Drainage, Swamps-marshes, Tides, ...**7.0291**

MULTISPECTRAL SENSING OF COASTAL ENVIRONMENTS ...Beaches, Depth, E M Radiation-general, Geomorphology-topography, Photography, Shoreline - Coastline, ...**4.0166**

REMOTE SENSOR OCEANOGRAPHY ...Cloud Temperature, Gulf of Mexico, Infrared Radiation, Satellites, Surface Environments, Temperature, ...**4.0170**

PRODUCTIVITY STUDIES IN NORTH CAROLINA SALT MARSHES ...Mapping, North Carolina, Primary Productivity, Productivity - Food Chain, Swamps-marshes, Tidewater Areas, ...**5.1017**

A RECONNAISSANCE OF COASTAL EROSION IN NORTH CAROLINA ...Beach, Development, Erosional Features, North Carolina, Photogrammetry, Reconnaissance, Shoreline - Coastline, Waves, ...**7.0268**

PROJECT AQUA-MAP - DEVELOPMENT OF AERIAL PHOTOGRAPHY AS AN AID TO WATER QUALITY

MANAGEMENT ...Effluents-waste Water, Management, Model Studies, New York, Pollutants-other, ...4.0167

GREAT LAKES RESEARCH - ICE CHARACTERISTICS ...Lake Superior, Micrometeorology, Origin, Petrofabrics, Radiation-terrestrial, Sea Ice, ...3.0082

GREAT LAKES RESEARCH - ICE COVER DISTRIBUTION ...Aerospatial, Alteration, Great Lakes-general, Petrofabrics, Sea Ice, ...3.0083

REMOTE SENSING OF ESTUARINE WATER AND VEGETATION, MARYLAND ...Bioindicators, Chemical-general, Estuaries, Physical-general, Remote Sensing -other, ...4.0144

COORDINATION OF ESTUARINE REMOTE SENSING IN ATLANTIC COAST REGION ...Atlantic Ocean-general, Estuaries, Satellites, ...4.0169

Cinematography

FILM PROJECT (KELP FORESTS) ...California, Fishery Development -other, Habitat Studies, Laminariaceae (non-specif.&ot), ...5.0678

Time-lapse Photography

MECHANICAL PROPERTIES OF MAMMALIAN CELLS ...Blood Cells, Cellular Membranes (non-spec.), Flow Metering Techniques, Suspension Culture, ...5.0992

Holography

HOLOGRAPHIC STUDIES OF MARINE ORGANISMS ...Acoustical, Lasers-masers, Plankton (non-specific), Plant Prod. (non-specific), Sampling, ...8.0060

Motion Pictures -non-specific

DISTRIBUTION OF LIFE WITH DEPTH ...Continental Shelf, North Carolina, Photography, Vertical Distribution, ...5.0885

Photography-chemistry

PHOTOGRAPHIC STANDARDS ...Photography, Standards, Specifications, ...8.0077

APPLICATION OF ISCC-NBS CENTROID COLORS AND METHOD OF DESIGNATION COLORS ...Colorimetry, Dyes and Coloring, Paint - General, Pigments, Standards, Specifications, ...4.0097

PHOTOGRAPHIC IMAGE EVALUATION ...Cybernetics, Imaging, Statistical Information Theory, ...4.0053

Physical Analysis

DEEP SEA SEDIMENT STUDIES ...Acoustical, Marine Soils, Mechanical Properties, Physical Properties, Shear Strength, ...8.0341

DESIGN AND DEVELOPMENT OF OCEANOGRAPHIC INSTRUMENTATION ...Bottom Sampling Device, Technique Development, Water Motion Recorders, ...8.0090

LONG RANGE SOFAR FLOATS ...Acoustical, Currents-ocean, Subsurface Environments, Water Motion, Water Motion Recorders, ...2.0025

INERTIAL TECHNIQUES ...Acoustical, Currents-ocean, Hydrodynamics, ...8.0099

GEOTHERMAL MEASUREMENTS ...Geomorphology-topography, Geothermal Gradient, Heat Flow Measurements, Physical Properties, Temperature, ...7.0136

PROPERTIES OF SEA WATER ...Compressibility--gas-liq, Conductivity, Density, Electrical, Expansion, Thermal, ...1.0153

A STUDY OF THE TEMPERATURE MICROSTRUCTURE AND EDDY TRANSPORT IN THE OCEAN FLOOR BOUNDARY LAYER ...Benthonic-bottom, Geothermal, Heat Flow Measurements, Temperature, Thermodynamics, ...1.0189

THERMAL PROPERTIES OF SEA WATER AT LOW TEMPERATURE AND HIGH PRESSURE ...Acoustical, Conduction, Expansion, Hydrodynamics, Thermal, ...1.0177

THERMAL WAKE STUDIES ...Thermal, Thermocline, Turbulence - Sea Water, Waves-internal, ...1.0174

Physical Forces

Electrical Fields

CORRELATION BETWEEN ELECTRICAL PATTERNS AND MORPHOGENETIC PATTERNS DURING REGENERATION ...Developmental Physiology, Hydra, Portuguese Man-of-war, Regeneration and Wound, ...5.0602

Gravitational Fields

SIMULATED WEIGHTLESSNESS IN FISH ...Behavior, Cardiovascular System, Fish -non-specific, Gravity, Proprioceptors, ...5.0275

Pressure & Mech Stress

HYDROSTATIC PRESSURE-TEMPERATURE, AS ENVIRONMENTAL PARAMETERS, ON GROWTH, BIOCHEMISTRY AND PHYSIOLOGY OF MICROORGANISMS ...Growth (non-specific & Ot.), Marine Biology (non-specific), Microorganisms (non-specific), Temperature, ...5.0821

COMPARATIVE PHYSIOLOGY OF BAROPHILIC BACTERIA ...Ionic Effect, Isolation From Nat. environ. , Marine Bacteria, Nutrition, Temperature, ...5.0751

Physiography

Erosion

PROPERTIES AND ORIGIN OF SEDIMENTS ON THE CONTINENTAL MARGIN OFF WESTERN U. S. ...Origin, Physical Properties, Sampling, Sedimentation, Shoreline - Coastline, ...7.0271

LITTORAL ENVIRONMENT OBSERVATION PROGRAM ...California, Development, Intertidal Areas, ...7.0289

ANALYSIS OF AN ATTEMPT TO CONTROL BEACH EROSION AT SCIENTISTS CLIFFS, MARYLAND ...Beaches, Chesapeake Bay, Engineering Studies-other, Groin, Maryland, ...8.0038

NATURE OF INTERTIDAL EROSION ON CORAL ATOLLS ...Atolls, Fossil Limestone, Intertidal Areas, Marine Biology (non-specific), ...7.0210

SEA FLOOR STUDIES - DEPOSITIONAL AND EROSION PROCESSES ...Bearing Capacity, Distribution, Lithification-general, Sedimentation, Stability Analysis, ...7.0200

Physical Features-general

PHYSICAL GEOGRAPHY OF TROPICAL COASTAL LOWLANDS ...Development, Geography-physical, Physical, Shore Features-general, Tropic, ...7.0298

Physiography-general

SUBMARINE TOPOGRAPHY ...Bathymetry, Origin, Pacific Ocean-south, Sedimentation, Textures-structures, ...7.0299

REDUCTION AND INTERPRETATION OF PHYSIOGRAPHIC DATA ACQUIRED ABOARD LAMONT RESEARCH VESSELS ...Data Analysis - General, Data Reduction and Analysis, Geology-general, Geomorphology-topography, Ocean Basins, ...7.0300

Terrain Analysis

ARCTIC RESEARCH LABORATORY ...Acoustical, Alaska, Arctic Ocean, Drift Stations, Seismic Studies, ...12.0003

Pigments - Animal-non-specific

CAROTENOIDS, CAROTENOID CHROMOPROTEINS, AND ASSOCIATED LIPIDS IN ANIMALS ...Carotenoid Pigments, Catabolism and Degradation, Metabolism, ...5.0944

Pilot Plant

MODEL ADVANCED WASTE-TREATMENT PLANT ...Activated Carbon, Lime Treatment, Material Recovery Wastes, Process Design, Solid Waste, ...8.0326

Plankton

Phytoplankton

MICROBIOLOGICAL ASSAYS OF SEAWATER USING RADIOISOTOPES ...Aquatic Ecology, Ciliates, Environmental Ecology, Environmental Physiology, Food Chains, Productivity - Food Chain, Thiamine, ...5.0811

BIOLOGY AND CHEMISTRY OF MARINE PLANKTON POPULATIONS ...Buoys, Chlorophyll, Vertical Distribution, Zooplankton, ...5.0798

PHYSICAL AND BIOLOGICAL OCEANOGRAPHY OF A LUMINOUS BAY ...Bays, Bioluminescence, Circulation-general, Jamaica, Model Studies, ...5.0976

THE BIOLOGY AND CHEMISTRY OF TRACE ELEMENTS IN MARINE AND ESTUARINE WATERS ...Chesapeake Bay, Estuaries, Productivity - Food Chain, Trace Element Analysis, Zooplankton, ...5.0975

DISSOLVED ORGANIC PHOSPHORUS IN NATURAL WATERS ...Lower Plants, Phosphorus, Water Analysis, ...1.0123

BIOLOGICAL PRODUCTIVITY IN THE SARGASSO SEA, THE GULF STREAM AND IN THE ATLANTIC COASTAL WATERS OFF CAPE HATTERAS ...Continental Shelf, Primary Productivity, Productivity - Food Chain, Proteins, ...5.1005

C-14 UPTAKE, LIMITING FACTORS AND EXCRETION PRODUCTS OF ANTARCTIC PHYTOPLANKTON ...Antarctic Ocean, Carbon, Primary Productivity, Secretions and Products, ...5.0813

AN ECOLOGICAL STUDY OF SOUTH BISCAYNE BAY IN THE VICINITY OF TURKEY POINT ...Applied Ecology, Balance of Nature, Bays, Electric Power Plants, Environmental Ecology, Florida, Thermal Pollution, ...5.0877

BIOLUMINESCENCE ...Autotrophic, Bays, Bioluminescence, Jamaica, Responses to Growth, ...1.0165

DETERMINATION OF CHLOROPHYLL DERIVATIVES ...Catabolism and Degradation, Cell Injury and Autolysis, Fluorometry, Marine Plants, ...5.0770

ECOLOGY OF PHYTOPLANKTON IN SEMI-TROPICAL ENVIRONMENTS ...Caribbean Sea, Range Or Territorial Distr. , Sub - Tropic, Temporal Distribution, Vertical Distribution, ...5.0778

MARINE PHYTOPLANKTON RESEARCH ...Algal Culture, Indian Ocean-general, Nutrition Studies, Pacific Ocean-general, Symbiosis, ...5.0847

LANGMUIR CIRCULATION AND PLANKTON ECOLOGY ...Circulation-general, Range Or Territorial Distr. , Vertical Distribution, Water Movement, Currents,, Wind Or Air Movement, Zooplankton, ...5.0794

ENVIRONMENTAL EFFECTS ON THE METABOLISM OF MARINE ALGAE ...Enzymes, Glycolic Acid, Laminariaceae (non-specif.&ot), Light, Marine Plants, Responses to Growth, ...5.0702

NUTRITIONAL STUDIES ON MARINE ORGANISMS ...Crustacea -non-specific, Invertebrate Nutrition, Nutrition Studies, Organics, ...5.1001

THE CHARACTERISTICS, MECHANISMS AND BIOGEOCHEMICAL CONSEQUENCES OF PHYTOPLANKTON FLOTATION ...Organics, Plant Lipids, Silicon, Size, Vertical Distribution, ...5.0826

STUDIES OF THE EFFECTS OF NUTRIENTS ON THE GROWTH OF PHYTOPLANKTON IN THE TROPICAL PAC. OCEAN ...Algal Culture, Growth Rate, Nutrition, Pacific Ocean-general, Tropic, ...5.0948

RELATIONSHIPS BETWEEN PHYTOPLANKTON AND ZOOPLANKTON IN THE CARIBBEAN SEA ...Caribbean Sea, Interbiotic Relat.(non-specif), Sargassum, Vertical Distribution, Zooplankton, ...5.0779

STANFORD BIOLOGICAL OCEANOGRAPHY ...Marine Biology, Primary Productivity, Productivity - Food Chain, Ships and Cruises, Training Grants, Fellowships, Zooplankton, ...11.0005

LACUSTRINE AND ESTUARINE FUNGI ...Aquatic Fungi (non-specific), Host-parasite Interactions, Marine Fungi (non-specific), Plant Morphology, Plant Taxonomy, Range Or Territorial Distr. , ...5.0731

NUTRIENT LIMITATION AND SOURCES OF NITROGEN FOR MARINE PRIMARY PRODUCTIO ...Marine Plants, Mathematical Biophysic, Nitrogen Fixation, Other Models, Primary Productivity, ...5.0845

ARCTIC BIOLOGICAL OCEANOGRAPHY ...Adaptation, Arctic Ocean, Growth and Differentiation, Potamogeton, Ruppia, Zostera.., Water - Light Qual. & Quant. , Water Temperature - other, ...5.0853

LIPID COMPOSITION OF ANTARCTIC MARINE ORGANISMS AND SEA WATER ...Antarctic Ocean, Fish -non-specific, Gulf of Mexico, Lipids, Low Temp. -but Above 32f, Productivity - Food Chain, Zooplankton, ...5.1031

BIOLOGICAL PRODUCTIVITY INVESTIGATIONS OF THE WATERS SURROUNDING ANTARCTICA ...Optical, Organics, Primary Productivity, Standing Crops, Weddell Sea, ...5.1030

OPERATION OF R/V TRIDENT ...Geomorphology-topography, Sea Floor Spreading, Ships and Cruises, Sound Production, Subbottom, Vertical Distribution, ...12.0045

HYDROLOGIC OPTICS - SPACELIGHT SPECTROSCOPY ...Attenuation, Intensity, Oceanic Fronts, Optical, Radiograph, Radiometer, Scattering, Spectrophotometer, ...4.0139

PREDICTION OF BIOLOGICAL POPULATIONS FROM THE PHYSICAL OCEANIC ENVIRONMENT ...Marine Environments-general, Range Or Territorial Distr. , Ships and Cruises, Temporal Distribution, Vertical Distribution, ...5.0844

BIOLOGICAL OCEANOGRAPHY ...Arctic, Organics, Temporal Distribution, ...5.1038

BIOLOGICAL AND CHEMICAL STUDY OF VIRGINIA'S ESTUARIES ...Estuaries, Nitrogen, Phosphorus, Population Dynamics, Primary Productivity, Virginia, ...1.0158

ANNUAL PHYTOPLANKTON PRODUCTION IN PUGET SOUND WATERS ...Copepods, Invertebrate Culture, Puget Sound, Standing Crops, Tides, ...5.0931

PLANKTON ECOLOGY OF BAR-BUILT ESTUARIES ...Estuaries, North Carolina, Primary Productivity, Productivity - Food Chain, Zooplankton, ...5.0816

CHANGES IN THE LIMITING NUTRIENT DUE TO TEMPORAL, GEOGRAPHIC, AND DEPTH VARIATIONS ...Depth, New York, Nutrients, Sub - Tropic, Water Depth, Water Levels, ...5.1004

ECOLOGY OF EELGRASS ...Alaska, Bering Sea, Food Webs, Potamogeton, Ruppia, Zostera.., Primary Productivity, ...5.0677

ENERGY AND ELEMENT TRANSFER IN LOWER MARINE TROPHIC LEVELS ...Copepods, Energy Budgets, Oregon, ...5.0823

BIOCHEMISTRY OF MARINE ORGANISMS ...Adsorption & Interface, Bioluminescence, Fouling, Plant Succession, Spectroscopy, ...5.0766

PHYSIOLOGICAL AND BIOCHEMICAL REQUIREMENTS OF PHYTOPLANKTON SPECIES ...Algal Culture, Marine Plants, Media, Nutrition Studies, Planktonic - Floating, ...5.0995

PRODUCTIVITY OF ESTUARINE AND MARINE ECOSYSTEMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Algae- General, Estuaries, Marine Plants, Primary Productivity, Standing Crops, ...5.1010

INPEC BIOLOGICAL OCEANOGRAPHY - (PHYTOPLANKTON AND ZOOPLANKTON RESEARCH) ...Food Supply, Pacific Ocean-north, Primary Productivity, Temporal Distribution, Zooplankton, ...5.0843

INTERACTIONS OF MARINE NUTRIENT COMPLEXES ...Iron, Marine Plants, Nutrients, Phosphorus, Tracers, ...5.0956

USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS ...Bioassays, Estuaries, Pollution - Effects of , Pollution Effects, Zooplankton, ...5.0832

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT MARINE PHYTOPLANKTON SPECIES ...Axenic Culture, Growth and Differentiation, Marine Biology, Marine Plants, Responses to Growth, ...5.0833

EFFECTS OF PETROLEUM AND PETROLEUM WASTES UPON IMPORTANT SPECIES OF ESTUARINE PHYTOPLANKTON AND ZOOPLANKTON ...Contamination - Water, Contamination, Pollution-water, Estuaries, Oil, Oil and Natural Gas - Sulfur, Zooplankton, ...5.0830

INTEGRATED FIELD AND LABORATORY SYSTEM FOR ASSAYING THE EFFECTS OF POLLUTANTS AND TOXICANTS UPON WATER QUALITY ...Algal Culture, Axenic Culture, Pollution - Effects of , Responses to Growth, ...5.0831

EFFECT OF NITRILOTRIACETIC ACID (NTA) UPON THE TOXICITY OF METALS TO SELECTED SPECIES OF ESTUARINE PHYTOPLANKTON ...Acids, Carbon, Chemicals (incl. algacides), Estuaries, Isotope Tracer-other, ...5.0829

DEVELOPMENT OF A METHOD FOR CHRONIC TOXICITY BIOASSAY USING MARINE PLANKTONIC ALGAE ...Algal Culture, Bioassays, Marine Plants, Microbiological Analysis, Monitoring (long Term Studies), Technique Development, Toxicology, ...5.0726

STANDING STOCK AND GROWTH OF BACTERIA IN THE SEA ...Atp X Adenosine Triphosphate, Carbohydrates, Growth (non-specific & Ot.), Marine Biology, Standing Crops, ...5.0749

Plankton (non-specific)

MARINE COMMUNITIES ...Benthic Organisms (non-specif), Environmental Ecology, Life History Studies, Model Studies, ...5.0861

PRODUCTIVITY OF OCEANIC POPULATIONS OF VERTICALLY MIGRATING ANIMALS ...Migration, Population Dynamics, Productivity (agricultural), Vertical Distribution, ...5.1019

AIR-SEA INTERACTION AND PLANKTON ECOLOGY ...Circulation-general, Environmental Ecology, Marine Biology (non-specific), Number Or Density, ...4.0078

METABOLISM OF MARINE ECOSYSTEMS ...Energy Budgets, Food Webs, Metabolism, Other, Productivity - Food Chain, ...5.0966

CARBON ISOTOPE GEOTHERMOMETRY ...Carbon, Carbonaceous Substance, Chemistry, Core Analysis, Geologic Thermometry, Paleotemperature, Temperature, ...7.0079

ORGANIC COMPOUNDS IN THE SEA AND IN MARINE SEDIMENTS ...Marine Biology (non-specific), Organic, Organics, Removal--organics, Water Analysis, ...1.0103

OCEANOGRAPHIC VESSEL OPERATIONS ...Equipment Purchase Operation, Geology-general, Pacific Ocean-north, Plant Prod. (non-specific), Ships and Cruises, ...12.0047

BIO-ACOUSTIC AND BIOLOGICAL SAMPLING GEAR STUDIES ...Acoustical, Indian Ocean-general, Mapping, Organism Sampling Devices, ...8.0126

HOLOGRAPHIC STUDIES OF MARINE ORGANISMS ...Acoustical, Holography, Lasers-masers, Plant Prod. (non-specific), Sampling, ...8.0060

THE OCCURRENCE AND EFFECTS OF PLANKTON IN THE SEA ...Air-sea Boundary-general, Marine Biology, ...5.0781

ARCTIC PLANKTON ECOLOGY ...Acoustical, Arctic, Marine Biology (non-specific), Oceanic Fronts, Population Dynamics, ...1.0017

AEGEAN SEA BIOLOGY ...Aegean Sea, Benthic Organisms (non-specif), Currents-longshore, Range Or Territorial Distr. , Temporal Distribution, ...5.0887

MEASUREMENT OF BIOLOGICAL FACTORS OF VARIOUS HABITATS, AND THEIR RELATION TO THE BIOLOGY OF THE COMMERCIALLY IMPORTANT SPECIES ...Chemical Measurements -water, Habitat Studies, Physical Measurements -water, Population Dynamics, Productivity - Food Chain, ...5.0219

CHANGES DURING EUTROPHICATION OF AN ESTUARY ...Estuaries, Eutrophication, North Carolina, Pollution - Effects of , ...5.0915

BIOLOGICAL OCEANOGRAPHY AND DETERIORATION, POLYMER STUDIES ...Corrosion General, Lubricants and Fluids, Marine Biology, Marine Biology (non-specific), Wear, Friction, ...8.0235

WATER QUALITY AND NUTRIENTS, SACRAMENTO-SAN JOAQUIN RIVER SYSTEM ...Environmental Ecology, Eutrophication, Fish -non-specific, Nutrients, Water Quality-general, ...6.0139

PLANKTON AND BENTHOS COMMUNITIES OF THE GREAT LAKES ...Aquatic Ecology, Benthic Organisms (non-specif), Gastropods -slugs,conch,snails, Lake Erie, Lugworms, Marine Segmentedworm, ...5.0801

FEEDING HABITS OF ATLANTIC TUNAS AND NEKTON ECOLOGY ...Atlantic Ocean-general, Food Supply, Productivity - Food Chain, Tuna, Mackerel, Albacore... , ...5.0204

CALIFORNIA CURRENT SURVEYS ...California Current, Environmental Ecology, Fish -non-specific, Pacific Ocean-east, ...4.0114

PLANKTON REARING, ENVIRONMENTAL REQUIREMENTS AND SENSITIVITY STUDIES ...Algal Culture, Bioindicators, Great Lakes-general, Microbiological Analysis, Water Quality-general, ...5.0804

THE ENVIRONMENTAL REQUIREMENTS OF MARINE PLANKTONIC ORGANISMS ...Bulk Culture -other, Marine Biology (non-specific), pH -water, Water Salinity, Water Temperature -other, ...5.0921

ELUCIDATION OF THE METABOLIC PATHWAYS OF MARINE PLANKTONIC ORGANISMS ...Marine Biology (non-specific), Metabolism (intracellular), Organelle-enzyme Assn, Purification & Isolate, Reaction Rates, ...5.0828

USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS ...Bioassays, Chemical Identification, Marine Biology (non-specific), Pollution - Effects of , ...6.0183

Zooplankton

HYDROGRAPHIC AND BIOLOGICAL SURVEY OF MONTSWEAG BAY AND VICINITY ...Bays, Maine, Number Or Density, Organism Sampling Devices, Vertical Distribution, ...5.0893

BIOLOGY AND CHEMISTRY OF MARINE PLANKTON POPULATIONS ...Buoys, Chlorophyll, Phytoplankton, Vertical Distribution, ...5.0798

THE BIOLOGY AND CHEMISTRY OF TRACE ELEMENTS IN MARINE AND ESTUARINE WATERS ...Chesapeake Bay, Estuaries, Phytoplankton, Productivity - Food Chain, Trace Element Analysis, ...5.0975

DISTRIBUTION AND BIOLOGY OF PACIFIC ZOOPLANKTON ...Animal Taxonomy, Pacific Ocean-general, Productivity - Food Chain, Range Or Territorial Distr. , Vertical Distribution, ...5.0745

DYNAMICS OF OCEANIC PLANKTON ...Growth Rate, Number Or Density, Productivity (agricultural), RNA , ...5.0825

ECOLOGICAL SIGNIFICANCE OF PARTICULATE MATTER IN THE SEA ...Atlantic Ocean-north, Interbiotic Relat.(non-specif), Marine Bacteria, Organic Matter Content -water, Temporal Distribution, Vertical Distribution, ...5.0754

LANGMUIR CIRCULATION AND PLANKTON ECOLOGY ...Circulation-general, Phytoplankton, Range Or Territorial Distr. , Vertical Distribution, Water Movement, Currents,, Wind Or Air Movement, ...5.0794

MICROSTRATIFICATION OF MARINE ZOOPLANKTON ...Environmental Physiology, Growth Rate, Thermal, Vertical Distribution, ...5.0753

LIVING AND FOSSIL ZOOPLANKTON, AND RELATED PROBLEMS OF PALEOLIMNOLOGY ...Aquatic Ecology, Biology, Ecological, Microfossils, Paleoecology, ...7.0171

RELATIONSHIPS BETWEEN PHYTOPLANKTON AND ZOOPLANKTON IN THE CARIBBEAN SEA ...Caribbean Sea, Interbiotic Relat.(non-specif), Phytoplankton, Sargassum, Vertical Distribution, ...5.0779

DEVELOPMENT AND EVALUATION OF A NEW TECHNIQUE FOR SAMPLING ZOOPLANKTON ...Organism Sampling Devices, Population Dynamics, Productivity - Food Chain, Technique Development, Vertical Distribution, ...5.0786

EXPERIMENTAL STUDIES ON THE BIOLOGY AND FOOD CHAIN ECONOMICS OF THE CHAETOGNATHS ...Energy Budgets, Productivity - Food Chain, Reproductive System, Whole Body Culture & Rearing, ...5.0777

STANFORD BIOLOGICAL OCEANOGRAPHY ...Marine Biology, Phytoplankton, Primary Productivity, Productivity - Food Chain, Ships and Cruises, Training Grants, Fellowships, ...11.0005

DEEP-WATER ZOOPLANKTON OF THE SARGASSO SEA ...Abyssal, Bermuda, Sargasso Sea, Vertical Distribution, ...5.0738

DIVERSITY, COMMUNITY STRUCTURE AND TROPHIC RELATIONS OF TROPICAL ZOOPLANKTON ...Bays, Interbiotic Relat.(non-specif), Productivity - Food Chain, Tropic, ...5.0785

MICROZOOPLANKTERS IN THE MARINE FOOD CHAIN ...Organism Sampling Devices, Population Dynamics, Productivity - Food Chain, Vertical Distribution, ...5.0748

HOLOGRAPHIC INSTRUMENTATION FOR MARINE PLANKTON STUDIES ...Lasers and Masers, Photography, ...8.0066

ECOLOGICAL INVESTIGATIONS OF MCMURDO SOUND ZOOPLANKTON ...Animal Taxonomy, Antarctica, Migration, Vertical Distribution, ...5.0756

LIPID COMPOSITION OF ANTARCTIC MARINE ORGANISMS AND SEA WATER ...Antarctic Ocean, Fish -non-specific, Gulf of Mexico, Lipids, Low Temp. -but Above 32f, Phytoplankton, Productivity - Food Chain, ...5.1031

PLANKTON ECOLOGY ...Aquatic Ecology, Copepods, Lake Michigan, Plankton Sampling, Ships and Cruises, ...5.0803

BIOLOGIC SOUND SCATTERING ...Acoustical, Population Dynamics, Reverberation, Scattering, Vertical Distribution, ...1.0060

A STUDY OF THE ICHTHYOPLANKTON ASSOCIATED WITH TWO OF NEW JERSEYS COASTAL INLETS ...Estuaries, Nets, Salinity, Thermal, Water Salinity, Water Temperature-non-specific, ...5.0806

A STUDY OF THE SEASONAL ABUNDANCE, DISTRIBUTION AND SPECIES COMPOSITION, WITH DEPTH, OF NEKTON FAUNA, WITH PARTICULAR EMPHASIS ON FISHES ...Fish -non-specific, Life History Studies, Number Or Density, Vertical Distribution, ...5.0114

A STUDY OF THE OPEN WATER DISTRIBUTION AND ABUNDANCE OF NET-PLANKTON AS AN INDEX OF EUTROPHICATION IN LAKE SUPERIOR ...Bioindicators, Data Acquisition, Eutrophication, Lake Superior, Plankton Sampling, ...6.0160

PLANKTON ECOLOGY OF BAR-BUILT ESTUARIES ...Estuaries, North Carolina, Phytoplankton, Primary Productivity, Productivity - Food Chain, ...5.0816

ZOOPLANKTON STUDIES IN BIG LAGOON, CALIFORNIA ...California, Lagoons, Plankton Sampling, Temporal Distribution, Vertical Distribution, ...5.0739

ZOOPLANKTON OF THE GULF OF MAINE ...Atlantic Ocean-north, Plankton Sampling, Population Dynamics, Vertical Distribution, ...5.0789

MARINE BIOLOGICAL INVESTIGATIONS - NEKTON OF INSIDE WATERS OF SOUTHEASTERN ALASKA ...Alaska, Plankton Sampling, Population Dynamics, Temporal Distribution, ...5.0521

MARINE BIOLOGICAL INVESTIGATIONS - SURFACE ZOOPLANKTON PROJECT ...Alaska, Number Or Density, Plankton Sampling, Vertical Distribution, ...5.0737

INPEC BIOLOGICAL OCEANOGRAPHY - (PHYTOPLANKTON AND ZOOPLANKTON RESEARCH) ...Food Supply, Pacific Ocean-north, Phytoplankton, Primary Productivity, Temporal Distribution, ...5.0843

ZOOPLANKTON DISTRIBUTION IN THE TROPICAL ATLANTIC ...Atlantic Ocean-general, Plankton Sampling, Range Or Territorial Distr. , Temperature, Tropic, Vertical Distribution, ...5.0771

PRODUCTIVITY MEASURES ...Number Or Density, Ocean Currents-other, Organism Sampling Devices, Pacific Ocean-east, Primary Productivity, Productivity - Food Chain, ...5.0940

USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS ...Bioassays, Estuaries, Phytoplankton, Pollution - Effects of , Pollution Effects, ...5.0832

DEVELOPMENT OF CULTURE METHODS FOR ECOLOGICALLY IMPORTANT MARINE ZOOPLANKTON SPECIES ...Aquatic Ecology, Copepods, Environmental Physiology, Invertebrate Culture, ...5.0834

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON ...Copepods, Oxygen, Water Salinity, Water Temperature-non-specific, ...5.0835

EFFECTS OF PETROLEUM AND PETROLEUM WASTES UPON IMPORTANT SPECIES OF ESTUARINE PHYTOPLANKTON AND ZOOPLANKTON ...Contamination - Water, Contamination, Pollution-water, Estuaries, Oil, Oil and Natural Gas - Sulfur, Phytoplankton, ...5.0830

Plankton Sampling

ECOLOGY OF PLANKTONIC FORAMINIFERA AND RELATED STUDIES ...Derivatives, Flagellates, Foraminifera, Gastropods -slugs,conch,snails, Vertical Distribution, ...5.0812

PLANKTON ECOLOGY ...Aquatic Ecology, Copepods, Lake Michigan, Ships and Cruises, Zooplankton, ...5.0803

LARVAL STUDY OF THE LOBSTER ...Atlantic Ocean-north, Habitat Studies, Lobsters, Long Island Sound, Mark, Tag Or Capture -other, Maturity & Growth Stages, ...5.0371

LAKE BORGNE-CHANDELEUR SOUND SYSTEM ...Benthic Fauna, Louisiana, Number Or Density, River Deltas, Vertical Distribution, ...5.0091

TIMBALIER - TERREBONNE BAYS SYSTEM ...Benthic Fauna, Louisiana, Number Or Density, River Deltas, Vertical Distribution, ...5.0092

BRETON SOUND - MOUTH OF MISSISSIPPI RIVER SYSTEM ...Benthic Fauna, Louisiana, Number Or Density, River Deltas, Vertical Distribution, ...5.0093

VERMILION - CALCASIEU - SABINE SYSTEM ...Benthic Fauna, Louisiana, Number Or Density, Salinity, Tides, Vertical Distribution, ...5.0094

ATCHAFALAYA RIVER - GAILOU LAKE SYSTEM ...Benthic Fauna, Lakes, Louisiana, Number Or Density, Vertical Distribution, ...5.0095

LAKE BORGNO - CHANDELEUR SOUND SYSTEM ...Data Acquisition, Gulf of Mexico, Maturity & Growth Stages, Nets, Population Dynamics, Shrimps - Common, ...5.0434

A STUDY OF THE OPEN WATER DISTRIBUTION AND ABUNDANCE OF NET-PLANKTON AS AN INDEX OF EUTROPHICATION IN LAKE SUPERIOR ...Bioindicators, Data Acquisition, Eutrophication, Lake Superior, Zooplankton, ...6.0160

ZOOPLANKTON STUDIES IN BIG LAGOON, CALIFORNIA ...California, Lagoons, Temporal Distribution, Vertical Distribution, Zooplankton, ...5.0739

RELICT COPEPODS FROM LAKE TUBORG, ELLESMERE ISLAND ...Brackish Water, Canada, Carbon-14, Copepods, Lakes, ...5.0388

ZOOPLANKTON OF THE GULF OF MAINE ...Atlantic Ocean-north, Population Dynamics, Vertical Distribution, Zooplankton, ...5.0789

MARINE BIOLOGICAL INVESTIGATIONS - NEKTON OF INSIDE WATERS OF SOUTHEASTERN ALASKA ...Alaska, Population Dynamics, Temporal Distribution, Zooplankton, ...5.0521

ROUTINE SAMPLING AT SEVEN INDEX STATIONS ...Bottom Sampling, Data Acquisition, Fish -non-specific, Lake Erie, Sampling, ...5.0214

MARINE BIOLOGICAL INVESTIGATIONS - SURFACE ZOOPLANKTON PROJECT ...Alaska, Number Or Density, Vertical Distribution, Zooplankton, ...5.0737

ZOOPLANKTON DISTRIBUTION IN THE TROPICAL ATLANTIC ...Atlantic Ocean-general, Range Or Territorial Distr. , Temperature, Tropic, Vertical Distribution, Zooplankton, ...5.0771

DESIGN AND DEVELOPMENT OF NEKTON SAMPLER ...Food Supply, Nektonic - Swimming, Organism Sampling Devices, Tuna, Mackerel, Albacore... , ...8.0129

Planktonic - Floating

MICROPLANKTON OF THE BEARPAW SHALE OF MONTANA AND NORTH DAKOTA ...Cretaceous Period, Fine-grained Clastics, Microfossils, Montana, North Dakota, ...7.0249

PHYSIOLOGICAL AND BIOCHEMICAL REQUIREMENTS OF PHYTOPLANKTON SPECIES ...Algal Culture, Marine Plants, Media, Nutrition Studies, Phytoplankton, ...5.0995

Planning

AN APPROACH TO MARINE RESOURCE DEVELOPMENT IN ALASKA ...Alaska, Marine Biology (non-specific), ...7.0001

SCIENCE AND ENGINEERING GOALS FOR THE INTERNATIONAL DECADE OF OCEAN EXPLORATION ...Economics, Oceanography-general, Project Review, Science & Technology, ...4.0118

STREAM IMPROVEMENT PLANNING ...Benefit-cost Analysis, Engineering Structures-general, Fish -non-specific, Management -other, Streams, ...5.0220

TECHNIQUES OF PLANNING ...Application, Control Systems, Management, Mathematical Analysis, Operations Research, Southern, Systems Analysis, ...9.0017

Plant Alkaloids

ORGANIC CHEMICAL STUDIES ON ANIMAL AND PLANT TOXIN ...Algal Toxins, Animal Toxins, Biochemical Analysis, Medicinal Plants, Plant Toxins, ...6.0115

Plant Characteristics

Adaptation

MACROMOLECULAR BASIS FOR ADAPTATION TO SALINITY CHANGES IN PRYMNESIUM PARVUM ...Growth Rate, Ionic Effect, Permeability, Prymnesium, Water Salinity, ...5.1012

ARCTIC BIOLOGICAL OCEANOGRAPHY ...Arctic Ocean, Growth and Differentiation, Phytoplankton, Potamogeton, Ruppia, Zostera.., Water - Light Qual. & Quant. , Water Temperature -other, ...5.0853

Growth Rate

MICROBIAL ACTIVITY IN NON AQUEOUS SYSTEMS ...Range Or Territorial Distr. , ...5.0782

Size

THE CHARACTERISTICS, MECHANISMS AND BIOGEOCHEMICAL CONSEQUENCES OF PHYTOPLANKTON FLOTATION ...Organics, Phytoplankton, Plant Lipids, Silicon, Vertical Distribution, ...5.0826

Plant Developmental Biology

MORPHOGENESIS OF THE DIATOM SHELL ...Algae- Diatoms, Cellular Membranes (non-spec.), Silica, Structural Functions, ...5.0734

MORPHOGENESIS OF THE DIATOM SHELL ...Algae- Diatoms, Cellular Membranes (non-spec.), Intracellular Localization, Organelle & Membrane Formation, Silica, ...5.0712

GROWTH AND CELLULAR MORPHOGENESIS IN NITELLA ...Elongation of Cell, Growth and Differentiation, Manometers, Nitella, Water Movement, ...5.0721

PRELIMINARY INVESTIGATION OF GROWTH AND DIFFERENTIATION IN MARINE COENOCYTIC ALGA, CAULERPA PROLIFERA ...Caulerpa, Differentiation Mechanism, Growth and Differentiation, Growth Rate, ...5.0711

DEVELOPMENT OF POLARITY IN THE FUCACEAN ZYGOTE ...Cellular Physiology, Differentiation Mechanism, Fucus, Polarity, Reproductive Physiology, ...5.0972

BIOLOGY AND PALEONTOLOGY OF MARINE DINOFLAGELLATES AND HYSTRICHOSPHERES ...Algae- Dinoflagellates, Algal Culture, Cell Cycle, Range Or Territorial Distr. , Spores, Vertical Distribution, ...5.0799

INDUCTION AND CONTROL OF DIFFERENTIATION IN ALGAE ...Control and Regulation, Differentiation Mechanism, Nutrition Studies, Photoperiodism, Rhodophyta (non-specific & Ot), ...5.0708

ULTRASTRUCTURE OF VARIOUS MARINE AND BRACKISH WATER ORGANISMS ...Developmental Biology - Animal, Differentiation Mechanism, Electron Microscopy, Marine Biology (non-specific), ...5.0640

EXPERIMENTAL ECOLOGY OF LOWER MARINE FUNGI ...Habitat Studies, Marine Fungi (non-specific), Phycomycetes, ...5.0808

RED TIDE TOXICITY ...Algal Toxins, Biochemical Analysis, Gas Chromatography, Gymnodinium, Pollution Sources-other, ...5.0780

BIOCHEMICAL STUDIES ON SILICEOUS SKELETAL FORMATION ...Algae- Diatoms, Cell Wall, Golgi Apparatus, Histochemistry - Cytochem, Silicon, ...5.0750

STRUCTURAL AND FUNCTIONAL ORGANELLE INTERACTIONS ...Differentiation Mechanism, Marine Plants, Organelle & Membrane Formation, Structural Functions, Tissue Techniques, ...5.0689

BIOLOGICAL ACTIVITIES OF MARINE FUNGI ...Endoparasites -other, Host-parasite Interactions, Invertebrate Pathology, Marine Fungi (non-specific), Oysters, Pathological Physiology, ...5.0699

Plant Morphology

TAXONOMY OF CALCAREOUS GREEN ALGAE ...Chlorophyceae (non-specif.&ot), Indian Ocean-general, Plant Taxonomy, Range Or Territorial Distr. , Reproductive Physiology, ...5.0718

MORPHOLOGY AND TAXONOMY OF MARINE FUNGI ...Habitat Studies, Mangroves, Marine Fungi (non-specific), Plant Taxonomy, Sub - Tropic, Tropic, ...5.0716

LACUSTRINE AND ESTUARINE FUNGI ...Aquatic Fungi (non-specific), Host-parasite Interactions, Marine Fungi (non-specific), Phytoplankton, Plant Taxonomy, Range Or Territorial Distr. , ...5.0731

Plant Morphology Parameters

Roots

MARINE ALGAE OF THE MANGROVE ROOT COMMUNITY ...Algae- General, Habitat Studies, Mangroves, Marine Plants, Puerto Rico, ...5.0723

Spores

FEASIBILITY OF THE APPLICATION OF PALYNOLOGICAL INVESTIGATION OF DEEP-SEA SEDIMENTS TO MAJOR GEOLOGICAL PROBLEMS ...Biology, Circulation-general, Paleoclimatology, Pollen, Pollens, ...7.0206

Plant Pathology

Bacteria

CONTROL OF PLANT PATHOGENS USING ACTIVE ANTIMICROBIAL SUBSTANCES ISOLATED FROM MARINE ALGAE ...Endogenous Biological Extracts, Fungi -non-specific, Growth Substances, Marine Plants, Nutrition in Disease, ...6.0127

Fungi -non-specific

CONTROL OF PLANT PATHOGENS USING ACTIVE ANTIMICROBIAL SUBSTANCES ISOLATED FROM MARINE ALGAE ...Bacteria, Endogenous Biological Extracts, Growth Substances, Marine Plants, Nutrition in Disease, ...6.0127

Host-parasite Interactions

LACUSTRINE AND ESTUARINE FUNGI ...Aquatic Fungi (non-specific), Marine Fungi (non-specific), Phytoplankton, Plant Morphology, Plant Taxonomy, Range Or Territorial Distr. , ...5.0731

ULTRASTRUCTURAL STUDIES OF PARASITIC AND SAPROPHYTIC FUNGI AND PROTOZOA ASSOCIATED WITH MARINE INVERTEBRATES ...Cell Cycle, Electron Microscopy, Myxomycetes, Protozoa, ...5.0839

BIOLOGICAL ACTIVITIES OF MARINE FUNGI ...Endoparasites -other, Invertebrate Pathology, Marine Fungi (non-specific), Oysters, Pathological Physiology, Plant Developmental Biology, ...5.0699

Nutrition in Disease

CONTROL OF PLANT PATHOGENS USING ACTIVE ANTIMICROBIAL SUBSTANCES ISOLATED FROM MARINE ALGAE ...Bacteria, Endogenous Biological Extracts, Fungi - non-specific, Growth Substances, Marine Plants, ...6.0127

Plant Physiology

Metabolism

Translocation

ECOLOGICAL STUDIES OF THE SOUTHEASTERN FLORIDA SEA GRASS COMMUNITY - PRIMARY PRODUCTION BY THALASSIA TESTUDINUM KONIG ...Elodea, Waterweed, Thalassia, Florida, Primary Productivity, Submerged Plants, Tropic, ...5.0695

Plant Resistance to ....

Heat Resistance

THERMAL DESTRUCTION OF TYPE E CLOSTRIDIUM BOTULINUM ...Clostridium Botulinum, Differentiation Mechanism, Food (epidemiology), Microbiological, Spore Studies, ...6.0006

Plant Taxonomy

THE MARINE ALGAE OF VIRGINIA ...Algae- General, Benthonic-bottom, Chesapeake Bay, Marine Plants, Virginia, ...5.0698

SYSTEMATICS, MORPHOLOGY, AND ECOLOGICAL DISTRIBUTION OF ALGO AND WOOD-INHABITING MARINE AND FRESHWATER FUNGI OF SURTSEY AND ICELAND ...Aquatic Fungi (non-specific), Iceland, Islands, Marine Fungi (non-specific), Range Or Territorial Distr. , ...5.0714

TAXONOMY OF CALCAREOUS GREEN ALGAE ...Chlorophyceae (non-specif.&ot), Indian Ocean-general, Plant Morphology, Range Or Territorial Distr. , Reproductive Physiology, ...5.0718

YEAR-ROUND PROGRAM OF RESEARCH IN MARINE ECOLOGY ...Animal Taxonomy, Aquatic Ecology, Marine Biology (non-specific), Plant Ecology (non-specific), Training Grants, Fellowships, ...5.0899

MORPHOLOGY AND TAXONOMY OF MARINE FUNGI ...Habitat Studies, Mangroves, Marine Fungi (non-specific), Plant Morphology, Sub - Tropic, Tropic, ...5.0716

SYSTEMATICS AND ECOLOGY OF SUBTIDAL BENTHIC MARINE ALGAE ...Algae- General, Benthic Flora, Benthonic-bottom, Habitat Studies, Marine Plants, Range Or Territorial Distr. , ...5.0701

LACUSTRINE AND ESTUARINE FUNGI ...Aquatic Fungi (non-specific), Host-parasite Interactions, Marine Fungi (non-specific), Phytoplankton, Plant Morphology, Range Or Territorial Distr. , ...5.0731

PHYSIOLOGY AND ECOLOGY OF MARINE DIATOMS ...Algae- Diatoms, Algal Culture, Habitat Studies, Marine Plants, Nutrition Studies, Physiological Ecology, ...5.0735

DISTRIBUTION OF ANTARCTIC MARINE FUNGI ...Antarctica, Marine Fungi (non-specific), Phycomycetes, Range Or Territorial Distr. , Ships and Cruises, Vertical Distribution, ...**5.0694**

EXPERIMENTAL CULTURE OF CALCAREOUS GREEN ALGAE OF CORAL REEFS ...Algal Culture, Biology, Calcium, Chlorophyceae (non-specif.&ot), Growth and Differentiation, Reefs, ...**5.0719**

ECOLOGICAL STUDIES OF ROCKY SUBTIDAL AREAS ...Animal Taxonomy, Habitat Studies, Marine Plants, ...**5.0865**

TAXONOMY AND ECOLOGY OF INSHORE MARINE MICROBIOTA ...Algae- General, Animal Taxonomy, Aquatic Ecology, Protozoa -other, Range Or Territorial Distr. , ...**5.0768**

CORAL ATOLL FLORA ...Atolls, Floras, Range Or Territorial Distr. , ...**5.0692**

INVESTIGATIONS ON THE CRUSTOSE CORALLINES OF THE NORTH ATLANTIC ...Atlantic Ocean-north, Diving and Scuba, Marine Plants, Rhodophyta (non-specific & Ot), Sedimentology-general, ...**7.0172**

COMPARATIVE BIOCHEMICAL AND MORPHOLOGICAL CHARACTERISTICS OF MARINE FUNGI FROM SHELLFISH ...Endoparasites -other, Fungal Culture, Histochemistry - Cytochem, Histology and Cytology, Marine Fungi (non-specific), ...**5.0791**

ISOLATION AND TAXONOMY OF YEASTS IN LAKES AND SEWAGE ...Bioindicators, Contamination, Pollution-water, Streams, Yeasts (non-specific), ...**5.0787**

STUDIES ON THE PROTISTAN CAUSING MALPEQUE DISEASE ...Invertebrate Pathology, Myxomycetes, Oysters, Pathology, Range Or Territorial Distr. , ...**5.0498**

Plastics

Elastomers, Rubber

CONSTRUCTION OF A FACILITY TO DEMONSTRATE OFFSHORE UNDERWATER TEMPORARY STORAGE OF STORM OVERFLOW FROM A COMBINATION SEWER ...Combined Sewer, Lake Erie, Storm Water, Tank, Pressure Vessel, Water Storage, ...**8.0328**

Epoxies

STRUCTURAL PLASTICS-DEEP SUBMERGENCE ...Design Data, Fiber, Filament, Glass, Materials Used Undersea, Plastic Matrix, ...**8.0213**

Platforms

STABLE OCEANIC STATION ...Engineering Studies-other, Floating Structure Stability, Underwater-construction, ...**8.0287**

MARINE METEOROLOGY UNTENDED STATION DEVELOPMENT ...Air Motion Instruments, Automatic Stations, Buoys, Meteorological Studies, Profiles, ...**8.0285**

OCEANOGRAPHIC ENGINEERING ...Bathythermographs, Engineering Studies-other, Experiments and Tests, Other-design-and-construction, Special Mission Ships, ...**8.0269**

WAVE UPLIFT FORCES ON HORIZONTAL PLATFORMS ...Hydrodynamic Structures, Wave Action, Waves, ...**8.0266**

FORCES AND MOTIONS INDUCED BY WAVES ON OCEAN PLATFORMS ...Coastal Engineering-other, Models, Wave Action, Waves, ...**8.0312**

MARINE ATMOSPHERIC RESEARCH FACILITY ...Air-sea Boundary-general, Instrumental Services, Meteorological Studies, Telemetry-other, Turbulence, Weather Modification-general, ...**8.0322**

WAVE GENERATION BY THE TURBULENT WIND FIELD OVER THE SEA ...Pressure-density, Turbulence, Velocity, Waves, Wind-water Interaction, ...**3.0008**

MOVABLE OCEAN MEASUREMENT SYSTEM ...Acoustical, Instrumental Services, Spectral Distribution, Spectrum, ...**8.0117**

HUDSON LABORATORIES SHIP SUPPORT ...Acoustical, Facilities, Modification-conversion, Scientific-service-support, Ships and Cruises, Special Mission Ships, ...**12.0021**

DEEP OCEAN ENGINEERING TECHNOLOGY ...Abyssal, Benthonic-bottom, Buoys, Experiments and Tests, Facilities, Scientific-service-support, ...**8.0270**

AN INVESTIGATION OF THE PERFORMANCE OF A COLUMN STABILIZED PLATFORM ...Engineering Studies-other, Experiments and Tests, Models, Ship Resistance Stability, ...**8.0296**

SEA USE ...General Synoptic Observations, Marine Biology, Oceanography-general, Pacific Ocean-east, Seamounts-guyots, ...**7.0303**

SONAR ACCURACY ...Acoustic, Acoustical, Fire Control, Instrumental Services, Sonar, Transmission, ...**1.0051**

GEOPHYSICAL SURVEYING AND CHARTING ...Airborne Gravimeters, Data Acquisition, Development of Models, Gravity Studies, Mapping, ...**7.0106**

ENVIRONMENTAL MEASURING EQUIPMENT ...Meteorological Studies, Polar, ...**4.0007**

DEVELOPMENT, TESTING AND EVALUATION OF MODIFICATIONS REQUIRED TO ADAPT DRILLING SAMPLING SYSTEMS TO THE PLATFORM ...Bottom Sampling Device, Coring and Dredging, Drilling and Coring, Equipment, Technique Development, ...**8.0256**

STANDARD MONITORING SECTIONS (ATLANTIC AND PACIFIC OCEAN) ...California Current, Kuroshio Current, Labrador Current, Salinity, Temperature, ...**4.0004**

Polished Sections

STRUCTURE, MINERALOGY, AND CHEMICAL COMPOSITION OF MARINE MANGANESE NODULES ...Chemistry, Manganese, Mineralogy, Origin, Precipitates, Textures-structures, ...**7.0028**

Pollens

FEASIBILITY OF THE APPLICATION OF PALYNOLOGICAL INVESTIGATION OF DEEP-SEA SEDIMENTS TO MAJOR GEOLOGICAL PROBLEMS ...Biology, Circulation-general, Paleoclimatology, Pollen, Spores, ...**7.0206**

Pollutant Identification

Bioindicators

A STUDY OF THE OPEN WATER DISTRIBUTION AND ABUNDANCE OF NET-PLANKTON AS AN INDEX OF EUTROPHICATION IN LAKE SUPERIOR ...Data Acquisition, Eutrophication, Lake Superior, Plankton Sampling, Zooplankton, ...**6.0160**

CLADOPHORA AS RELATED TO POLLUTION IN WESTERN LAKE ERIE ...Algal Pollutant Sources, Chemical Analysis, Cladophora, Lake Erie, Mapping, ...**6.0170**

BACTERIOLOGICAL STUDY OF THE POLLUTION OF KANEOHE BAY, OAHU ...Bays, Coliforms (non-specific), Hawaii, Nitrogen, Sewage, Streptococcus Fecalis, ...**6.0150**

REMOTE SENSING OF ESTUARINE WATER AND VEGETATION, MARYLAND ...Aerial Photography, Chemical-general, Estuaries, Physical-general, Remote Sensing -other, ...**4.0144**

PESTICIDE MONITORING PROGRAM ...Estuaries, Gas Chromatography, Monitoring Systems, Oysters, Persistance of Residues, ...**6.0147**

LAKE HURON CHEMICAL CONTROL ...Chemical-general, Ectoparasites, Flow Characteristics -water, Lake Huron, Selectivity, ...**6.0159**

PLANKTON REARING, ENVIRONMENTAL REQUIREMENTS AND SENSITIVITY STUDIES ...Algal Culture, Great Lakes-general, Microbiological Analysis, Plankton (non-specific), Water Quality-general, ...**5.0804**

REARING AND SENSITIVITY STUDIES OF VARIOUS LIFE STAGES OF MARINE MACROINVERTEBRATES ...Crabs, Shrimps - Common, Whole Body Culture & Rearing, ...**5.0496**

STUDY OF NITROGEN METABOLISM IN MARINE ALGAE ...Enzymes, Marine Plants, Microbiological Analysis, Pollution - Effects of , Quantitative & Qualitative, ...**5.0727**

MEASUREMENT OF THE RATE OF CARBON DIOXIDE (C14) FIXATION INTO SUBCELLULAR FRACTIONS OF ALGAE ...Algae- General, Algal Culture, Carbon, Carbon Dioxide Fixation, Growth Rate, Intracellular Localization, ...**5.0728**

ISOLATION AND TAXONOMY OF YEASTS IN LAKES AND SEWAGE ...Contamination, Pollution-water, Plant Taxonomy, Streams, Yeasts (non-specific), ...**5.0787**

MICROBIOLOGY OF ESTUARINE AND SHELLFISH POLLUTION ...Clams, Estuaries, Oysters, Pollution Effects, Sanitation, Waste Water Treatment-general, ...**6.0162**

Chemical Identification

STEROLS AND LIPIDS IN WATER POLLUTION ...Effluents-waste Water, Lipid Hydroperoxides, Pollutants - Path of , Sewage, Sterols, ...6.0186

USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS ...Bioassays, Marine Biology (non-specific), Plankton (non-specific), Pollution - Effects of , ...6.0183

Physical Parameters

ULTRAVIOLET ABSORPTION IN COASTAL WATERS ...Biological, Marine Plants, Plant Prod. (non-specific), Sewage, Total Organic Carbon, Ultra - Violet Radiation, ...6.0138

Pollutants-general

EFFECTS OF RIVERS ON THE METABOLISM OF TEXAS BAYS ...Bays, Nutrients, Primary Productivity, Streams, Texas, Water Quality-general, ...6.0187

REMOTE SENSING OF DELAWARE ESTUARY ...Aircraft, Delaware, Estuaries, ...4.0168

MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES ...Fish -non-specific, Great Lakes-general, Insecticides - non-specific, Monitoring Systems, Sampling, ...6.0120

ORGANISMS RESPONSIBLE FOR TOXICITY OF ALASKAN CLAMS ...Alaska, Biological Pollutants -general, Clams, Food Spoilage Detection, Microbiological, ...5.0344

Pollutants-other

OIL LEAKS AND SLICKS ...Aerial Photography, Aircraft, Oil, Satellites, Technique Development, ...4.0145

PROJECT AQUA-MAP - DEVELOPMENT OF AERIAL PHOTOGRAPHY AS AN AID TO WATER QUALITY MANAGEMENT ...Aerial Photography, Effluents-waste Water, Management, Model Studies, New York, ...4.0167

Pollutants - Path of

ECOLOGICAL STUDIES OF RADIOACTIVITY IN THE COLUMBIA RIVER ESTUARY AND ADJACENT PACIFIC OCEAN ...Columbia River, Contamination - Water, Organism Sampling Devices, Pacific Ocean-north, Radioactivity-general, ...6.0172

STABLE CARBON AND OXYGEN ISOTOPE RATIO VARIATIONS IN THE FLOW TO CARBON AND OXYGEN THROUGH NORMAL AND POLLUTED AQUATIC SYSTEMS ...Carbon, Element Ratios, Organic-general, Oxygen, Sewerage Systems-other, Water Analysis, ...1.0132

IMPACT AND FATE OF POLLUTION IN ESTUARIAL WATERS ...Degradation, Estuaries, Massachusetts, Pesticides - non-specific, Pollution Effects, ...6.0153

EDDY DIFFUSION AND BACTERIAL REDUCTION IN WASTE FIELDS ...Bacterial Pollutant Sources, Diffusion, Dispersion -water, Dyes, Mixing, Sewers, ...6.0137

STEROLS AND LIPIDS IN WATER POLLUTION ...Chemical Identification, Effluents-waste Water, Lipid Hydroperoxides, Sewage, Sterols, ...6.0186

RADIONUCLIDES IN THE SAVANNAH RIVER ESTUARY AND ADJACENT COASTAL WATERS ...South Carolina, ...6.0185

MOVEMENT OF RADIONUCLIDES IN THE LOWER COLUMBIA RIVER ...Absorbed Load, Adsorption Capacity, Columbia River, Estuaries, Radioactivity-general, ...6.0178

THE MOVEMENT OF RADIONUCLIDES IN THE COLUMBIA RIVER ESTUARY ...Absorbed Load, Adsorption Capacity, Columbia River, Estuaries, Radioactivity-general, ...6.0180

PESTICIDE KINETICS ...Aquatic Or Soil-aquatic Cycles, Degradation, Estuaries, Insecticides -non-specific, Marine Biology (non-specific), ...6.0148

FATE OF INLAND DERIVED POLLUTANTS IN AN ESTUARY ...Estuaries, Pollution - Effects of , Pollution Abatement, Pollution Sources-general, Systems Analysis, ...6.0133

ESTUARINE DIFFUSION OF POLLUTANTS ...Dilution-other, Estuaries, Oregon, Salinity, Stratification, ...6.0175

Pollution - Effects of

ECOLOGICAL SURVEY OF EFFLUENT DISCHARGE AT TWO PULP MILLS IN HUMBOLDT COUNTY, CALIFORNIA ...California, Chemical Analysis (water), Effluents-waste Water, Pollution Effects, Pulp, Paper , and Logging, ...5.0858

EFFECTS OF HEATED WATER DISCHARGE ON THE MARINE ENVIRONMENT ...Marine Environments-general, Pollution Sources-other, Thermal Pollution, ...6.0142

CALORIC - AN INVESTIGATION OF HEAT RELEASE PATTERNS ASSOCIATED WITH PRESENT AND PLANNED LAKESHORE ELECTRICAL POWER PLANTS ...Electric Power Plants, Lake Erie, Model Studies, Nuclear Power, Temperature, Thermal Pollution, ...1.0186

ECOLOGICAL EFFECTS OF ENVIRONMENTAL & LOW LEVEL POLLUTION STRESSES ON METABOLIC REQUIREMENTS FOR GROWTH OF GULF COAST FISHES ...Environmental Ecology, Gulf of Mexico, Metabolism, Pollution Effects, Pollution Sources-general, Stress, ...5.0328

OPTIMUM ECOLOGICAL DESIGNS FOR ESTUARINE SYSTEMS OF NORTH CAROLINA ...Domestic Wastes-general, Estuaries, Marine Biology (non-specific), North Carolina, Pollution Effects, Productivity - Food Chain, ...5.0913

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...Aquatic Ecology, Estuaries, Mans Activities, Persistance of Residues, Pesticides -non-specific, Population Dynamics, Standing Crops, ...5.0880

DETERMINATION OF SAFE LEVELS OF POLLUTION IN PUERTO RICO ...Bays, Contamination - Water, Meteorological Studies-general, Puerto Rico, Recreation Sites, Water Properties-general, ...6.0181

A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY ...Commercial Fishing, Estuaries, Mans Activities, Spawning & Nesting Sites, Texas, ...5.0926

CHANGES DURING EUTROPHICATION OF AN ESTUARY ...Estuaries, Eutrophication, North Carolina, Plankton (non-specific), ...5.0915

EFFECTS OF THERMAL POLLUTION ON PRODUCTIVITY AND STABILITY OF ESTUARINE COMMUNITIES ...Aquatic Ecology, Environmental Ecology, Estuaries, Plant Prod. (non-specific), Thermal Pollution, ...6.0152

WATER QUALITY - BENTHIC INVERTEBRATE RELATIONSHIPS IN ESTUARIES ...Benthic Fauna, Benthonic-bottom, Estuaries, Maine, Pollution Effects, ...5.0894

INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...Adsorption Capacity, Chemical, Eutrophication, Lake Erie, Microorganisms (non-specific), Sediments, ...6.0169

THE ECOLOGIC IMPACT OF THE INTERACTIONS AMONG MICROORGANISMS AND AQUATIC CONTAMINANTS IN LAKE ERIE ...Lake Erie, Primary Productivity, Responses to Growth, Sediments, Water Bacteria, ...5.0819

THE BIOLOGY OF THE INFAUNA OF A TROPICAL SOFT BOTTOM AREA ...Aquatic Ecology, Benthic Fauna, Estuaries, Florida, Intertidal Areas, ...5.0879

ENVIRONMENTAL BIOLOGY OF TOMALES DAY ...Aquatic Ecology, Bays, Benthic Fauna, California, Mans Activities, ...5.0860

DEMONSTRATION OF THE LIMITATIONS AND EFFECTS OF WASTE DISPOSAL ON AN OCEAN SHELF ...Marine Plants, Ocean, Outlet, Pollution Effects, Sewers, ...6.0146

EFFECTS OF WATER POLLUTION IN SAN FRANCISCO BAY ...Bays, Economic Impact, Recreation Sites, San Francisco Bay, Social Aspects, Water Utilization -domestic, Welfare Economics, ...6.0140

A SURVEY OF THE MARINE ENVIRONMENT FROM FORT ROSS, SONOMA COUNTY, TO POINT LOBOS, MONTEREY COUNTY ...California, Effluents-waste Water, Marine Environments-general, Pollution Effects, ...9.0003

ECOLOGY OF KRAFT PAPER MILL EFFLUENT IN SAPELO & ST. CATHERINES SOUNDS, GA ...Aquatic Ecology, Georgia, Pollution Effects, Pulp, Paper , and Logging, Streams, ...5.0886

AN ENVIRONMENTAL SURVEY OF THE DAMARISCOTTA RIVER ESTUARY, LINCOLN COUNTY, MAINE ...Circulation -water, Estuaries, Nutrients, Salinity, Sedimentology-general, ...5.0895

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...Bioassay, Estuaries, Persistance of Residues, Sevin, Swamps-marshes, ...5.0918

EFFECTS OF KRAFT PULP MILL EFFLUENTS ON THE GROWTH AND PRODUCTION OF FISH ...Contamination - Water, Industrial Wastes, Pollution Effects, Population Dynamics, Pulp, Paper , and Logging, Salmon & Trout - Non-specific, ...5.0311

GREAT LAKES RESEARCH - SPOIL DISPOSAL EFFECTS ...Dispersion awater, Great Lakes-general, Sediments, Spoil Banks, Suspension, Water Properties-general, ...6.0157

STUDY OF EFFECTS OF OFFSHORE DUMPING ...Circulation-general, Dispersion -water, Engineering Studies-other, Pollution Sources-other, Shoreline - Coastline, ...6.0144

EFFECTS OF HEATED WATER IN A TIDAL ESTUARY ...Chesapeake Bay, Electric Power Plants, Pollution Effects, Thermal Pollution, Tidal Streams, Water Properties-general, ...6.0145

INFLUENCE OF INDUSTRIAL AND MUNICIPAL WASTES ON ESTUARINE AND OFF SHORE WATER QUALITY ...Domestic Wastes-general, Estuaries, Industrial Wastes, Washington, ...6.0192

SAN PABLO BAY STUDY ...Bays, Benthic Fauna, Bottom Sampling Device, Excavation, Spoil Banks, ...6.0136

MEASUREMENT OF RADIONUCLIDES IN ESTUARINE AND MARINE ENVIRONMENTS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Estuaries, Marine Environments-general, Pollution Effects, Radioactivity-general, Reactor Sites & Rad Waste, ...5.0912

THE EFFECTS OF ENVIRONMENTAL CONDITIONS ON THE SPAWNING AND SURVIVAL OF FRY OF THE WALLEYE ...Environmental Effects-geologic, Eutrophication, Lake Erie, Temperature, Walleyes, ...5.0299

ARTIFICIAL SELECTION - FISH ...Female Gametes, Fish -non-specific, Genetic Resistance, Pesticides -non-specific, Selection & Breeding, ...5.0256

LABORATORY BIOASSAYS ...Contamination - Water, Fish, Laboratory, Laboratory Animals, Pollution Sources-general, ...5.0882

RELATION OF RIVER-RUN IMPOUNDMENTS TO SALMON PRODUCTION ...Aquatic Ecology, Engineering Structures-general, Environmental Changes, Environmental Ecology, Mans Activities, Salmon & Trout - Non-specific, ...5.0222

ESTUARINE ECOSYSTEMS ...Aquatic Ecology, Estuaries, Pesticides, Pollution Effects, Population Dynamics, ...5.0883

EFFECTS OF INDUSTRIAL EXPANSION ON THE AQUATIC ENVIRONMENT OF ESTUARINE AREAS ...Columbia River, Estuaries, Salmon & Trout - Non-specific, ...5.0226

ECOLOGY OF WESTERN GULF ESTUARIES (ESTUARINE PROGRAM) ...Coastal Engineering-other, Estuaries, Gulf of Mexico, Habitat Studies, Mans Activities, ...5.0928

DISPOSAL TO MARINE WATERS ...Circulation-general, Model Studies, Monitoring (long Term Studies), Pollution Sources-general, Shoreline - Coastline, ...6.0177

RELATIONSHIP BETWEEN GLACIAL FLOUR POLLUTION AND POLLUTANTS FROM OTHER SOURCES ...Adsorption, Adsorption Capacity, Alaska, Estuaries, Glacial Clastics, Pulp, Paper , and Logging, Size, ...6.0134

FATE OF INLAND DERIVED POLLUTANTS IN AN ESTUARY ...Estuaries, Pollutants - Path of , Pollution Abatement, Pollution Sources-general, Systems Analysis, ...6.0133

ENVIRONMENTAL CONDITIONS AND POPULATION DYNAMICS IN SELECTED UNPOLLUTED ESTUARIAL AND COASTAL AREAS ...Aquatic Ecology, Contamination - Water, Habitat Studies, Marine Biology (non-specific), Toxic Substances -non-specific, ...5.0922

USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS ...Bioassays, Chemical Identification, Marine Biology (non-specific), Plankton (non-specific), ...6.0183

MARINE BIOLOGICAL ASSESSMENT OF POLLUTIONAL FATE ...Contamination - Water, Crustacea -non-specific, Fish - non-specific, Nets, ...6.0176

HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE FISHES ...Contamination - Water, Killifishs - Cyprinodon, Pathology, Pollution Effects, ...5.0323

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Publications

Handbooks

REVISION OF THE CLASSIFICATION AND PHYLOGENY OF THE SUBORDER BALANOMORPHA (CIRRIPEDIA - THORACICA) ...Animal Taxonomy, Barnacles, Collections, Nomenclature, Classification, Vertical Distribution, ...**5.0704**

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HANDBOOK OF MARINE TECHNOLOGY ...Engineering Studies-general, General Sea Water Chemistry, Geology-general, Marine Biology, Meteorological Studies, Submersibles, ...**11.0014**

TAXONOMY AND DISTRIBUTION OF CLUPEOIDS AND REVISION OF THE GENUS ILISHA OF THE FAMILY CLUPEIDAE ...Alewife,menhaden,shad,herring, Animal Taxonomy, Indian Ocean-general, Nomenclature, Classification, Range Or Territorial Distr. , ...**5.0088**

SYSTEMATICS AND ECOLOGY OF MARINE BIRDS ...Animal Taxonomy, Range Or Territorial Distr. , Shorebirds-gulls,terns,skimmer, World Wide, ...**5.0582**

INVENTORY AND ATLAS OF GULF COAST SPORT FISHING FACILITIES ...Atlases-maps, Fishing, Gulf of Mexico, Management -other, ...**9.0006**

INVENTORY AND ATLAS OF MARINE SPORT-FISHING FACILITIES ...Atlantic Ocean-north, Eastern, Fishing, Recreation Sites, ...**9.0012**

ATLAS OF MARINE FAUNA ...Atlantic Ocean-north, Crustacea -non-specific, Fish -non-specific, Mollusks -non-specific & Other, ...**5.0101**

INVESTIGATION OF THE BIOLOGY AND POPULATION STRUCTURE OF GULF MENHADEN ...Alewife,menhaden,shad,herring, Bone, Gulf of Mexico, Population Dynamics, Vertebrate Anatomy, ...**5.0128**

TAXONOMY AND BIOLOGY OF CLUPEOID FISHES ...Alewife,menhaden,shad,herring, Anchovies, Animal Taxonomy, Atlantic Ocean-general, ...**5.0060**

SYSTEMATICS OF CARANGID FISHES ...Animal Taxonomy, Collections, Maturity & Growth Stages, Pompanos, Scads, Jacks, Species, Comparison of , ...**5.0061**

Periodicals

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REPORT DISTRIBUTION ...Commercial Fishing, Fats - Lipids & Oils, Oysters, Spawning & Nesting Sites, ...**11.0041**

Pubilications -other

CONTINUED STUDIES OF THE SYSTEMATICS AND ZOOGEOGRAPHY OF WESTERN ATLANTIC CAECIDAE ...Animal Taxonomy, Atlantic Ocean-general, Derivatives, Gastropods -slugs,conch,snails, Invertebrate Anatomy, ...**5.0696**

THE ALPHEID SHRIMP OF AUSTRALIA ...Animal Taxonomy, Australia, Collections, Shrimps - Common, ...**5.0425**

MONOGRAPH OF THE CEPHALOPODS OF THE NORTH ATLANTIC ...Animal Taxonomy, Atlantic Ocean-north, Depth, Nomenclature, Classification, Optical, Salinity, Temperature, ...**5.0411**

A SYSTEMATIC STUDY OF ENTOCYTHERID OSTRACODS ...Animal Taxonomy, Madagascar-malagasy Republic, New Zealand, Shrimps - Seed Or Mussel, South America, ...**5.0492**

MONOGRAPH OF THE FISHES OF THE ORDER PLECTOGNATHI ...Animal Taxonomy, Bone, Comparative Anatomy, Fish -other, Vertebrate Anatomy, ...**5.0146**

REVISION OF GENERA AND SUBGENERA OF WATER MITES OF THE WORLD ...Animal Taxonomy, Growth, Moulting & Metamorph, Nomenclature, Classification, Ticks & Mites, World Wide, ...**5.0627**

SUPPORT OF THE COMMITTEE ON OCEANOGRAPHY OF THE NATIONAL ACADEMY OF SCIENCES ...Committee-support, Oceanography-general, ...**12.0022**

SYSTEMATICS AND ZOOGEOGRAPHY OF ANTARCTIC CEPHALOPODS ...Animal Taxonomy, Antarctic Ocean, Australian, Octopus, Squid, Cuttlefish... , ...**5.0412**

STUDIES ON ANACANTHINE FISHES ...Animal Taxonomy, Atlantic Ocean-north, Continental Shelf, Fish -other, ...**5.0048**

DESCRIPTIONS OF NEW SHARKS ...Animal Taxonomy, Collections, Nomenclature, Classification, Sharks, ...**5.0057**

Tables, Compilations, Catalogs

DECOMPRESSION TABLE DEVELOPMENT ...Decompression Sickness, Digital Computer Applications, Divers, Diving and Scuba, Mathematical Biophysic, Medical Studies, ...**6.0098**

NITROGEN-OXYGEN DECOMPRESSION TABLES FOR ALTITUDE FLIGHT ...Decompression Sickness, Diving, Manned Satelite, Safety, Space Medicine, ...**6.0099**

CONFERENCE REPORTS ...Geophysics-general, Marine Biology, Meetings, ...**11.0034**

THERMAL STRUCTURE ...Data Reduction and Analysis, Salinity, Sea Level Variations, ...**1.0184**

MARINE ZOOGEOGRAPHY ...Fish -non-specific, ...**5.0593**

INTERNATIONAL INDIAN CEAN EXPEDITION PHYSICAL AND CHEMICAL ATLAS ...Data & Statistics Storage, Data Analysis - General, General Sea Water Chemistry, Indian Ocean-general, Water Properties-general, ...**4.0130**

OCEANOGRAPHIC RESEARCH ...Abyssal, Benthonic-bottom, Fouling, Geomorphology-topography, Marine Soils, ...**8.0343**

A GLOBAL DIRECTORY OF TIDAL CONSTANTS ...Arcs, Maps-other, Tides, ...**2.0079**

HYDRAULIC BULLETIN ...Current Research Projects, Hydraulic Engineering-other, Hydraulics-general, ...**8.0177**

THREE-DIMENSIONAL GLOBAL CLIMATOLOGY ...Air Motion-general, Applied Climatology, General Movement, Patterns, Spectral Analysis, ...**3.0067**

PUBLICATION OF OPPORTUNITIES IN OCEANOGRAPHY ...Oceanography-general, ...**11.0020**

TAXONOMIC REVISION OF BATHYLAGIDAE ...Animal Taxonomy, Deepsea Smelts, Temperate, Tropic, ...**5.0055**

SURVIVAL CRAFT DRIFT AND LEEWAY ...Air Motion Instruments, Buoys, Currents-ocean, Equipment, Ocean-lakes, Operational Aspect, ...**6.0129**

Puerto Rico

MARINE ALGAE OF THE MANGROVE ROOT COMMUNITY ...Algae- General, Habitat Studies, Mangroves, Marine Plants, Roots, ...**5.0723**

ECOLOGY OF THE PORITES FURCATA REEF-FLAT COMMUNITY ...Anthozoa, Panama, Productivity - Food Chain, Reefs, ...**5.0867**

DETERMINATION OF SAFE LEVELS OF POLLUTION IN PUERTO RICO ...Bays, Contamination - Water, Meteorological Studies-general, Pollution - Effects of , Recreation Sites, Water Properties-general, ...**6.0181**

IGNEOUS AND SEDIMENTARY ROCKS FROM THE NORTH WALL OF THE PUERTO RICO TRENCH ...Igneous Rocks, Petrology, Sedimentary Rocks, Trenches, ...**7.0083**

GEOLOGIC INVESTIGATIONS IN PUERTO RICO & THE CARIBBEAN ...Caribbean Sea, Element Ratios, Plutonic, Sedimentary Petrology, Volcanic, ...**7.0042**

MARINE BIOLOGY PROGRAM ...Distribution, Productivity - Food Chain, Radioecology, Rare Earths, Trace Elements, ...**1.0128**

PUERTO RICO COOP - MONA PASSAGE ...Continental Shelves, Land Economics, Mine Wastes, Oil - Petroleum, Potential of Deposit, Sands and Gravels, ...**7.0034**

LABORATORY OF NEUROBIOLOGY ...Facilities, Nervous System, ...**12.0044**

Puget Sound

BOTTOM CURRENTS AND THE MOVEMENT OF SEDIMENT ACROSS THE CONTINENTAL SHELF ...Bed Load, Columbia River, Continental Shelf, Sediment Transport-general, Unsteady, ...**2.0047**

MEASUREMENTS OF OXYGEN CONSUMPTION BY THE SEA BED IN DEEP WATER OF PUGET SOUND ...Benthic Flora, Chemistry, Oxygen, Oxygen Content -water, ...**5.1036**

OCEANOGRAPHIC PROCESSES IN ESTUARINE AND COASTAL WATERS ...Oceanic Fronts, Pacific Ocean-east, Shoreline - Coastline, Washington, Water Properties-general, ...**4.0050**

MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...Bays, Environmental Ecology, Mortality Rates, Oysters, Pathology, ...**5.0510**

TAG DETECTION ...Commercial Fishing, Number Or Density, Salmon -coho,chinook,sockeye..., Streams, Tags, ...**8.0148**

MARKED COHO LIBERATION ...Captive Rearing, Columbia River, Mark, Tag Or Capture -other, Salmon -coho,chinook,sockeye.., ...5.0164

ANNUAL PHYTOPLANKTON PRODUCTION IN PUGET SOUND WATERS ...Copepods, Invertebrate Culture, Phytoplankton, Standing Crops, Tides, ...5.0931

EPIDERMAL PAPILLOMAS IN PLEURONECTID FISHES ...Cancer, Papillomas of Animals, Pathology, Righteye Flounders, ...5.0314

Pulse-labelling

UPTAKE OF ORGANIC COMPOUNDS BY MARINE INVERTEBRATES ...Amino Acids, Amino Acids -non-specific, Chemoreceptors, Invertebrate Nutrition, Invertebrates -non-specific, Marine Biology, Metabolism, ...5.0938

Qualitative

CORRELATION OF SUBMARINE VOLCANIC ASH BY CATHODO-LUMINESCENCE ...Correlation, Extrusives, Geochronology-general, Luminescence, Size, ...7.0255

Radar

LOOK-OUT ASSIST DEVICE ...Fog-haze-mist, Navigation, Navigation Communication, Visibility, Warning-systems, ...8.0146

Radiation Effects

Direct Effects

Invertebrates

COLUMBIA RIVER STUDIES ...Columbia River, Contamination - Water, Oysters, Pollution Effects, Radioactivity-general, Reproductive System, ...5.0518

Vertebrates Excl. man

THE EFFECTS OF RADIATION ON THE PHYSIOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Cooperative-studies, Radioactive Fallout, ...5.0294

THE EFFECTS OF RADIATION ON THE MORPHOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Cooperative-studies, Fish -other, Radiation Sensitivity-, Vertebrate Anatomy, ...5.0295

Radiation Effects-non-specific

WORKSHOP ON EFFECTS OF ATOMIC RADIATION ON OCEANOGRAPHY ...Atomic Bomb, Commercial Fishing, Meetings, Radioactivity, ...11.0015

EFFECTS OF IRRADIATION, TEMPERATURE AND OTHER ENVIRONMENTAL FACTORS ON SALMONID EMBRYOS ...Basic Embryology, Salmon & Trout - Non-specific, Water Light Quality & Quantity, Water Temperature-non-specific, X and Gamma Rays, ...5.0336

PROTEIN SYNTHESIS DURING THE EARLY DEVELOPMENT OF THE SEA URCHIN EMBRYO ...Basic Embryology, Cell Injury and Autolysis, Proteins, Ribosomes, Sea Urchins & Other Echinoderm, ...5.0537

BIOLOGICAL INVESTIGATIONS WITH ISOTOPES ...Algae-General, Facilities, Isotopes -non-specific, Marine Plants, Radioecology, ...11.0025

Radiation Sensitivity-

MICROFLORA OF RADIATION PASTEURIZED SEAFOODS ...Microbiological, Organoleptic Studies, Radiation, Refrigeration, Shellfish -non-specific, ...6.0171

THE EFFECTS OF RADIATION ON THE MORPHOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Cooperative-studies, Fish -other, Vertebrate Anatomy, Vertebrates Excl. man, ...5.0295

SURVIVAL OF FOOD PATHOGENS IN RADIATION PASTEURIZATION SEAFOOD ...Cell. env.(non-specific & Ot.), Cobalt, Crabs, Food Bacteria, Radiation, ...6.0063

Radiations

Atomic Bomb

WORKSHOP ON EFFECTS OF ATOMIC RADIATION ON OCEANOGRAPHY ...Commercial Fishing, Meetings, Radiation Effects-non-specific, Radioactivity, ...11.0015

Diagnostic Procedures

ACCUMULATION OF RADIOACTIVITY BY INVERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Contamination - Water, Cooperative-studies, Radioactivity-general, Reactor Sites & Rad Waste, ...5.0474

X and Gamma Rays

EFFECTS OF IRRADIATION, TEMPERATURE AND OTHER ENVIRONMENTAL FACTORS ON SALMONID EMBRYOS ...Basic Embryology, Radiation Effects-non-specific, Salmon & Trout - Non-specific, Water Light Quality & Quantity, Water Temperature-non-specific, ...5.0336

Radioactive Dating

MARINE GEOCHEMISTRY RESEARCH ...Depth, Gases, Mineral Genesis, Mineralogy, Sedimentation, Thermodynamics, ...7.0055

THE GEOCHEMISTRY OF RADIOACTIVE ELEMENTS IN THE MARINE ENVIRONMENT - THE GEOCHEMISTRY OF LANDLOCKED SEAS ...Distribution, Element Ratios, Oceans - Sea Water, Sedimentation, Uranium, ...1.0095

RADIATION, DOSIMETRY, CORRELATION AND DATING OF CALCAREOUS DEEP-SEA CORES ...Carbonates-general, Core Analysis, Correlation, Sedimentation, Thermoluminescence, ...7.0251

NUCLEAR CHEMISTRY AND GEOCHEMISTRY RESEARCH ...Iron, Nuclear - General, ...7.0082

DATING MARINE SEDIMENTS ...Argon-potassium, Loess, Optical, Origin, Rate of Deposition, Terrigenous, ...7.0201

RADIOCARBON DATING OF A HAWAIIAN REEF PROFILE ...Carbon-14, Hawaii, Reefs, Sea Level Variations, ...7.0087

POTASSIUM/ARGON DATING OF DEEP-SEA SAMPLES ...Abyssal, Argon-potassium, Geologic Age Relations, Microfossils, Sea Floor Spreading, Tertiary Period, ...7.0066

RADIOSTRONTIUM DEPOSITION OVER THE OCEAN ...Circulation-general, Nuclear Explosions - Fallout, Precipitation-general, Radioactivity, Strontium, ...6.0165

Radioactivity

Neutron Activation

NEUTRON ACTIVATION ANALYSIS OF IRON METEORITES ...Activation Analysis, Aluminum, Argon-potassium, Carbon, Cosmogenous, Iron, ...7.0065

Radiochemical Analysis

RADIOELEMENT STUDIES IN THE OCEANS - LANTHANIDES IN SEA WATER AND THEIR INTERACTIONS WITH MARINE SEDIMENTS AND SUSPENSOIDS ...Atlantic Ocean-general, Lanthanide Series, Oceanic Fronts, Trace Elements, Water Analysis, ...1.0104

COLUMBIA RIVER SEDIMENT STUDIES ...Columbia River, Geochemical Analysis, Radioactivity-general, Sediments, Self-purification, ...6.0190

FUNDAMENTAL RADIATION CHEMISTRY RESEARCH ...Antibiotics, Chemical Analysis, Fish -non-specific, Packaging, Radiation, ...6.0040

Radium

INVESTIGATIONS OF URANIUM AND THORIUM SERIES ISOTOPE DISEQUILIBRIUM IN THE OCEAN AND IN PLEISTOCENE SEDIMENTS ...Chemistry, Glacial History, Quaternary Period, Radioactivity, Thorium, Uranium, ...1.0120

DISTRIBUTION OF CARBON AND RADIUM IN THE ANTARCTIC WATERS ...Carbon, Gases, Indian Ocean-general, Sampling, Trace Elements, ...1.0109

Range and Tracking Systems

Doppler

FEASIBILITY STUDY FOR SYNTHETIC APERTURE ARRAY ACOUSTIC BOTTOM MAPPING SYSTEM ...Acoustic, Charts, Geomorphology-topography, Mapping, ...4.0061

SATELLITE TIME DISSEMINATION ...Airborne Probing, Communication & Navigation, Navigation, Signal Generators, Standards, Specifications, Time Measurements, ...4.0091

Radar

RADAR SCATTERING ...Waves, ...4.0103

AIRBORNE REMOTE SENSING OCEANOGRAPHY PROJECT ...Aircraft, Data Acquisition, Instrumental Services, Photography, Satellites, ...4.0155

Range and Tracking-other

VHF SATELLITE COMMUNICATIONS ...Navigation, Space Crafts, Very High Frequency, ...4.0105

EXPERIMENTAL SEA ICE OBSERVATIONAL TECHNIQUES ...Data Acquisition, Imaging, Instrumental Services, Satellites, Sea Ice, ...4.0156

Rare Earths

MARINE BIOLOGY PROGRAM ...Distribution, Productivity - Food Chain, Puerto Rico, Radioecology, Trace Elements, ...1.0128

Rates, Doses, Concentrations

PESTICIDE RESISTANT FISH IN NATURAL ECOSYSTEMS ...Animal Resistance -other, Endrin, Fish, Food Chains, Animal And/or Man, Pollution Effects, ...5.0277

Reactors

Fuel

ECONOMICS OF NUCLAER FUEL ...Costs, Merchant-ships, Nuclear, ...4.0178

NUCLEAR FUEL COST ANALYSIS MODEL ...Applications, Cost Analysis, Nuclear Power, ...4.0070

Recognition Systems

APOLLO TEST SITE EXPERIMENT ...Aircraft, Estuaries, Hydraulics-general, Hydrology-general, Remote Sensing-general, ...4.0146

UNDERWATER ACOUSTIC HOLOGRAPHIC DISPLAY ...Acoustical, Detectors, Holography, Instrumental Services, Photography, ...8.0137

Recreation

Demand and Use

Projected Demand

HAWAII STATE COMPREHENSIVE OUTDOOR RECREATION PLAN ...Hawaii, Inventories, Methods, Recreation, Survey, User Characteristics, ...9.0009

PUBLIC INVESTMENT CRITERIA FOR WATER-ORIENTED RECREATION IN THE LAKE ERIE BASIN ...Alternative Planning, Costs, Finance, Fiscal, Pollution Abatement, Recreation Sites, ...9.0016

ECONOMIC EVALUATION OF PRIMARY BENEFITS FOR FISHING AND HUNTING BASED ON THE NATIONAL SURVEYS OF FISHING AND HUNTING ...Fishing, Hunting, Survey, ...9.0001

Inventories

HAWAII STATE COMPREHENSIVE OUTDOOR RECREATION PLAN ...Hawaii, Methods, Projected Demand, Recreation, Survey, User Characteristics, ...9.0009

Methods

HAWAII STATE COMPREHENSIVE OUTDOOR RECREATION PLAN ...Hawaii, Inventories, Projected Demand, Recreation, Survey, User Characteristics, ...9.0009

Recreation Activities

Boating

CRITERIA FOR EVALUATING THE QUALITY OF WATER BASED RECREATION FACILITIES ...Fishing, Marinas, Standards, Swimming, User Characteristics, Water Quality-general, ...9.0015

Fishing

STUDIES ON THE SPORT FISHERY FOR BILLFISHES AND TUNAS IN THE WESTERN ATLANTIC AND SOUTHEASTERN PACIFIC OCEAN. ...Atlantic Ocean-general, Pacific Ocean-general, Swordfish, Tuna, Mackerel, Albacore... , ...5.0069

CRITERIA FOR EVALUATING THE QUALITY OF WATER BASED RECREATION FACILITIES ...Boating, Marinas, Standards, Swimming, User Characteristics, Water Quality-general, ...9.0015

ECONOMIC EVALUATION OF PRIMARY BENEFITS FOR FISHING AND HUNTING BASED ON THE NATIONAL SURVEYS OF FISHING AND HUNTING ...Hunting, Projected Demand, Survey, ...9.0001

ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...Aquatic Ecology, Environmental Ecology, Estuaries, Migration, Oregon, Population Dynamics, ...5.0216

MIGRATORY HABITS OF LARGE SHARKS ...Atlantic Ocean-north, Migration, Sharks, Tags, ...5.0147

INVENTORY AND ATLAS OF GULF COAST SPORT FISHING FACILITIES ...Atlases-maps, Gulf of Mexico, Handbooks, Management -other, ...9.0006

INVENTORY AND ATLAS OF MARINE SPORT-FISHING FACILITIES ...Atlantic Ocean-north, Eastern, Handbooks, Recreation Sites, ...9.0012

INVENTORY OF THE GULF ESTUARY SYSTEM ...Bays, Data Acquisition, Estuaries, Gulf of Mexico, Sedimentology-general, ...4.0047

1965 SALT-WATER ANGLING SURVEY ...Animal Taxonomy, Censusing, Fish -non-specific, ...9.0011

Hunting

ECONOMIC EVALUATION OF PRIMARY BENEFITS FOR FISHING AND HUNTING BASED ON THE NATIONAL SURVEYS OF FISHING AND HUNTING ...Fishing, Projected Demand, Survey, ...9.0001

EVALUATION OF THE ATLANTIC FLYWAY SEA DUCK KILL ...Age, Anseriformes -other, Mortality Rates, Sex -non-specific, Species, Comparison of , ...5.0606

Swimming

CRITERIA FOR EVALUATING THE QUALITY OF WATER BASED RECREATION FACILITIES ...Boating, Fishing, Marinas, Standards, User Characteristics, Water Quality-general, ...9.0015

Standards

CRITERIA FOR EVALUATING THE QUALITY OF WATER BASED RECREATION FACILITIES ...Boating, Fishing, Marinas, Swimming, User Characteristics, Water Quality-general, ...9.0015

Survey

HAWAII STATE COMPREHENSIVE OUTDOOR RECREATION PLAN ...Hawaii, Inventories, Methods, Projected Demand, Recreation, User Characteristics, ...9.0009

ECONOMIC EVALUATION OF PRIMARY BENEFITS FOR FISHING AND HUNTING BASED ON THE NATIONAL SURVEYS OF FISHING AND HUNTING ...Fishing, Hunting, Projected Demand, ...9.0001

Types of Resources

ISLAND STUDY ...Conservation-general, Islands, Land Economics, Recreation Sites, United States-general, ...9.0005

User Characteristics

HAWAII STATE COMPREHENSIVE OUTDOOR RECREATION PLAN ...Hawaii, Inventories, Methods, Projected Demand, Recreation, Survey, ...9.0009

CRITERIA FOR EVALUATING THE QUALITY OF WATER BASED RECREATION FACILITIES ...Boating, Fishing, Marinas, Standards, Swimming, Water Quality-general, ...9.0015

Recreation Sites

DETERMINATION OF SAFE LEVELS OF POLLUTION IN PUERTO RICO ...Bays, Contamination - Water, Meteorological Studies-general, Pollution - Effects of , Puerto Rico, Water Properties-general, ...6.0181

ENHANCEMENT OF RECREATIONAL USES OF ESTUARINE WATERS THROUGH STUDY OF POTENTIAL CONTROL METHODS FOR STINGING SEA NETTLES ...Biological Control, Chesapeake Bay, Estuaries, Jelly Fish, Water Quality-general, ...5.0605

PUBLIC INVESTMENT CRITERIA FOR WATER-ORIENTED RECREATION IN THE LAKE ERIE BASIN ...Alternative Planning, Costs, Finance, Fiscal, Pollution Abatement, Projected Demand, ...9.0016

EFFECTS OF WATER POLLUTION IN SAN FRANCISCO BAY ...Bays, Economic Impact, Pollution - Effects of , San Francisco Bay, Social Aspects, Water Utilization -domestic, Welfare Economics, ...6.0140

INVENTORY AND ATLAS OF MARINE SPORT-FISHING FACILITIES ...Atlantic Ocean-north, Eastern, Fishing, Handbooks, ...9.0012

ISLAND STUDY ...Conservation-general, Islands, Land Economics, Types of Resources, United States-general, ...9.0005

Red Sea

BIOLOGY-MIDDLE EAST WATERS ...Cell Cycle, Marine Biology (non-specific), Middle-east-general, Phenology, Reproductive System, Synchronization, ...5.0929

STABLE ISOTOPE STUDIES ON COEXISTING MINERALS IN MARINE SEDIMENTS ...Coring and Dredging, Diagenesis, Genetic Relationships, Mineralogy, Salinity, Thermal, ...1.0106

GEOPHYSICAL AND GEOCHEMICAL STUDY OF RED SEA MINERAL DEPOSITS ...Coring and Dredging, Gulf of Aden, Igneous Activity - Volcanism, Mineralogy, Thermal, ...7.0023

MARINE BIOLOGY OF RED SEA AND EASTERN MEDITERRANEAN ...Benthic Flora, Mapping, Population Dynamics, ...5.0891

BIOTA OF THE RED SEA AND EASTERN MEDITERRANEAN ...Marine Biology (non-specific), Migration, Survey Studies, ...5.0691

Reefs

MANAGEMENT OF THE ENIWETOK MARINE BIOLOGICAL LABORATORY ...Atolls, Facilities, Lagoons, Marine Biology (non-specific), ...12.0028

TRACE ELEMENT AND STABLE ISOTOPE STUDIES OF CORAL REEF CARBONATES ...Diagenesis, Element Ratios, Fossil Limestone, Paleoenvironments, Trace Element Analysis, ...7.0086

ECOLOGY OF PANAMANIAN REEF COMMUNITIES ...Behavioral Ecology, Invertebrates -non-specific, Panama, Productivity - Food Chain, Tropic, ...5.0866

HYDROGRAPHY, SEDIMENTATION AND CHEMICAL ASPECTS OF THE REEF ENVIRONMENT ...Aquatic Soils, Currents-ocean, Environmental Ecology, Fish -non-specific, ...5.0212

DESIGN, CONSTRUCTION AND LONGEVITY OF ARTIFICIAL FISHING REEFS ...Atlantic Ocean-north, Currents-ocean, Tides, ...9.0013

Regional Areas

ECONOMICS OF WATER QUALITY FOR A REGIONAL SYSTEM ...Delaware River, Economic Efficiency, Estuaries, Finance, Water Demand, Water Quality-general, ...9.0018

Regional United States

Eastern

STUDIES OF BARACLINIC TIDAL MOTIONS ON THE CONTINENTAL SHELF OF THE EASTERN UNITED STATES ...Continental Shelf, Meteorological Studies, Sea Level Variations, Tides, Water Motion, ...2.0081

STRUCTURE OF CONTINENTAL RISE OFF EASTERN NORTH AMERICA ...Cenozoic Era-general, Continental Drift, Continental Slopes, Sedimentary History, Sedimentation, ...7.0117

INVENTORY AND ATLAS OF MARINE SPORT-FISHING FACILITIES ...Atlantic Ocean-north, Fishing, Handbooks, Recreation Sites, ...9.0012

CIRCULATION ON THE CONTINENTAL SHELF ...Atlantic Ocean-north, Circulation-general, Continental Shelf, Water Motion Recorders, ...2.0027

Northeast

CONSUMER EDUCATION AND MARKET DEVELOPMENT ...Atlantic Ocean-north, Fish & Shellfish, ...6.0032

ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST ...Commercial Fishing, Fish & Shellfish, Market Structure, Marketing, Math Models, Productivity (agricultural), ...6.0151

ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST ...Commercial Fishing, Fish & Shellfish, Market Structure, Maryland, Processing, ...4.0182

ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST ...Commercial Fishing, Consumer Pref. & Consumption, Fish -non-specific, Market Structure, ...4.0183

BIOCHEMISTRY OF FISH AS RELATED TO HUMAN NUTRITION ...Amino Acids, Hypoxanthine, ...6.0053

MARKET STRUCTURE OF COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST ...Commercial Fishing, Consumption, Haddock, Market Structure, Refrigeration, ...4.0186

THE STRUCTURE OF DECISION MAKING IN MAJOR MARKETING AGENCIES OF FOOD FISH IN THE N.E. UNITED STATES ...Fish -non-specific, Marketing, Price & Value, Production & Processing, Shelf Life & Storage, ...6.0078

ECONOMIC IMPACT OF MARINE-ORIENTED ACTIVITIES IN THE SOUTHERN NEW ENGLAND MARINE REGION ...Economics, Regional Economic Impact, ...4.0187

MARINE POLYCHAETE WORMS OF THE NEW ENGLAND REGION (GULF OF ST. LAWRENCE TO CHESAPEAKE BAY) ...Animal Taxonomy, Lugworms, Marine Segmented-worm, Nomenclature, Classification, Vertical Distribution, ...5.0574

MARINE NEMATODES OF THE CAPE COD AREA ...Animal Taxonomy, Collections, Habitat Studies, Nematoda -other, ...5.0566

Southern

IDENTIFICATION AND DESCRIPTION OF FISH LARVAE ...Animal Taxonomy, Atlantic Ocean-north, Fish -non-specific, Life History Studies, ...5.0074

TECHNIQUES OF PLANNING ...Application, Control Systems, Management, Mathematical Analysis, Operations Research, Planning, Systems Analysis, ...9.0017

Western

QUATERNARY ENVIRONMENTS AND BIOTAS ...Biofacies, Intertidal Areas, Paleotemperature, Population - Distribution, Quaternary Period, ...7.0157

Remote Areas

REMOTE SENSING, EVERGLADES AREA, FLORIDA ...Computer Applications, Florida, Swamps-marshes, Visible Light, Water Properties-general, ...4.0161

Remote Sensing

Aircraft

WATER-TO-AIR RETRIEVAL ...Mathematical Models, Recovery Operations, Suspension-release, ...8.0276

OIL LEAKS AND SLICKS ...Aerial Photography, Oil, Pollutants-other, Satellites, Technique Development, ...4.0145

APOLLO TEST SITE EXPERIMENT ...Estuaries, Hydraulics-general, Hydrology-general, Recognition Systems, Remote Sensing-general, ...4.0146

FLIGHT TESTING OF HIGH PERFORMANCE WIDE-RANGE IMAGE SPECTROPHOTOMETER (WISP) SYSTEM ...Optical, Spectral Reflectance, Technique Development, ...4.0152

HIGH FREQUENCY OCEAN WAVES ...Forecasting-prediction, Photogrammetry, Radar, Waves, Wind-water Interaction, ...2.0121

SUPERCONDUCTING MAGNETOMETER SYSTEMS EVALUATION ...Magnetometers, Superconducting Magnets, Technique Development, ...**8.0098**

AIRBORNE REMOTE SENSING OCEANOGRAPHY PROJECT ...Data Acquisition, Instrumental Services, Photography, Radar, Satellites, ...**4.0155**

REMOTE SENSING, GULF COASTAL AREA, CENTRAL FLORIDA ...Aquifers, Fresh Water, Saline Water Systems, Temperature, Tides, ...**4.0160**

REMOTE SENSING OF DELAWARE ESTUARY ...Delaware, Estuaries, Pollutants-general, ...**4.0168**

AERIAL SEA SURFACE TEMPERATURE SURVEYS OF U S. COASTAL WATERS ...Infrared Radiation, Migration, Productivity - Food Chain, Temperature, Water Temperature-non-specific, ...**4.0148**

Automatic Stations

GULF STREAM TRANSPORT ...Gulf Stream, Hydrodynamics, Ships and Cruises, Water Motion Recorders, ...**2.0029**

OCEAN BOTTOM EMPLACED GEOPHYSICAL STATION ...Benthonic-bottom, Dynamic Gravimeters, Geophysical Equipment, Gravity Studies, Instrumental Services, Pacific Ocean-east, Temperature, Water Motion Recorders, ...**4.0035**

Balloons

WATER-TO-AIR RETRIEVAL ...Aircraft, Mathematical Models, Recovery Operations, Suspension-release, ...**8.0276**

E M Radiation-general

RESEARCH NEEDS FOR REMOTE SENSING OF THE ENVIRONMENT ...Committee-support, Remote Sensing-general, ...**4.0141**

MULTISPECTRAL SENSING OF COASTAL ENVIRONMENTS ...Aerial Photography, Beaches, Depth, Geomorphology-topography, Photography, Shoreline - Coastline, ...**4.0166**

Infrared Radiation

APPLICATION OF METEOROLOGICAL SATELLITE SENSING TO GENERAL CIRCULATION MODELS ...Meteorologic Model Studies, Particle-gas Transfer, Patterns, Satellites, Thermodynamics, Weather Forecasting, ...**4.0137**

SATELLITE SEA ICE STUDIES USING HRIR ...Arctic Ocean, Data Analysis - General, Satellites, Sea Ice, Technique Development, ...**3.0075**

WATER PHYSICS AND CHEMISTRY ...Chemical-general, Hydrodynamics, Lasers-masers, Satellites, Thermal Pollution, ...**4.0147**

INFRARED RADIOMETRY FOR SURFACE HEAT FLOW ...Atmosphere Radiation, Heat and Radiation Transfer, Heat Exchange, Technique Development, Temperature, ...**4.0153**

AIRBORNE SEA SURFACE MEASUREMENTS IN THE EQUATORIAL PACIFIC ...Atolls, Humidity, Mapping, Oceanic Fronts, Radiation Detection, Temperature, ...**1.0190**

CIRCULATION IN THE GULF OF MEXICO ...Circulation-general, Currents-ocean, Gulf of Mexico, Mapping, Oceanic Fronts, ...**2.0022**

AIR-SEA EXCHANGE ...Albedo, Heat and Radiation Transfer, Massachusetts, Temperature, Towers, ...**3.0026**

REMOTE SENSOR OCEANOGRAPHY ...Aerial Photography, Cloud Temperature, Gulf of Mexico, Satellites, Surface Environments, Temperature, ...**4.0170**

VISUAL LANDING AIDS FIELD ...Atmosphere Optical Phenomena, Detectors, Electric Lighting Systems, Fog-haze-mist, Lighting, ...**4.0086**

REFLECTIVITY AND EMISSIVITY STANDARDS ...Atmosphere Radiation, Interferometry, Radiation, Radiation-general, Standards, Specifications, ...**4.0142**

AERIAL SEA SURFACE TEMPERATURE SURVEYS OF U S. COASTAL WATERS ...Aircraft, Migration, Productivity - Food Chain, Temperature, Water Temperature-non-specific, ...**4.0148**

Lasers-masers

FEASIBILITY STUDY FOR A GATED-LASER, IMAGE-AMPLIFIER UNDERWATER VISION SYSTEM ...Electric Lighting Systems, Image Converters, Optical Devices, Photography, Technique Development, ...**8.0108**

WATER PHYSICS AND CHEMISTRY ...Chemical-general, Hydrodynamics, Infrared Radiation, Satellites, Thermal Pollution, ...**4.0147**

HOLOGRAPHIC STUDIES OF MARINE ORGANISMS ...Acoustical, Holography, Plankton (non-specific), Plant Prod. (non-specific), Sampling, ...**8.0060**

WAVE RECORDING AND ANALYSIS ...Data Reduction and Analysis, Pressure, Radar, Sonar, Statistics-general, Water Motion Recorders, Waves, ...**2.0101**

Microwave Radiation

MICROWAVE RADIOMETER DEVELOPMENT ...Instrumental Services, Microwave Techniques, Radiation Detection, Radiation-terrestrial, Wave Form, ...**8.0056**

ENVIRONMENTAL APPLICATIONS OF PASSIVE MICROWAVE SENSORS ...Beaches, Ice-general, Sea Ice, Sedimentology-general, Snow-general, Soil Engineering Investigation, ...**4.0136**

REMOTE SENSING ...Currents-ocean, Gases, Mixing, Oil, Salinity, Temperature, ...**4.0171**

Radar

HIGH FREQUENCY OCEAN WAVES ...Aircraft, Forecasting-prediction, Photogrammetry, Waves, Wind-water Interaction, ...**2.0121**

RADAR SCATTERING ...Waves, ...**4.0103**

WAVE RECORDING AND ANALYSIS ...Data Reduction and Analysis, Lasers-masers, Pressure, Sonar, Statistics-general, Water Motion Recorders, Waves, ...**2.0101**

Remote Sensing -other

REMOTE SENSOR SYSTEMS INTERGRATION AND PRESENT OPERATIONS DESCRIPTION ...Commercial Fishing, Fish -non-specific, Spacecraft Sensory Devices, Spectral Reflectance, ...**4.0154**

REMOTE SENSING OF ESTUARINE WATER AND VEGETATION, MARYLAND ...Aerial Photography, Bioindicators, Chemical-general, Estuaries, Physical-general, ...**4.0144**

Remote Sensing-general

APOLLO TEST SITE EXPERIMENT ...Aircraft, Estuaries, Hydraulics-general, Hydrology-general, Recognition Systems, ...**4.0146**

SENSING OF ENVIRONMENT ...Survey Studies, ...**4.0164**

RESEARCH NEEDS FOR REMOTE SENSING OF THE ENVIRONMENT ...Committee-support, E M Radiation-general, ...**4.0141**

ARCTIC SUPPORT ...Arctic, Scientific-service-support, Sea Ice, Submerged Ships, ...**3.0080**

Satellites

INTEGRATION OF DOPPLER SATELLITE AND LORAC NAVIGATIONAL SERVICES ...Doppler, Loran, Navigation, ...**4.0110**

SATELLITE INTERROGATE ENVIRONMENTAL BUOY DEVELOPMENT ...Navigation Communication, ...**8.0308**

OIL LEAKS AND SLICKS ...Aerial Photography, Aircraft, Oil, Pollutants-other, Technique Development, ...**4.0145**

SATELLITE SEA ICE STUDIES USING HRIR ...Arctic Ocean, Data Analysis - General, Infrared Radiation, Sea Ice, Technique Development, ...**3.0075**

WATER PHYSICS AND CHEMISTRY ...Chemical-general, Hydrodynamics, Infrared Radiation, Lasers-masers, Thermal Pollution, ...**4.0147**

VISIBLE REGION INSTRUMENTATION FOR OCEANOGRAPHIC SATELLITES ...Currents-ocean, Geomorphology-topography, Mapping, Photography, Shoals, ...**8.0088**

MARINE GRAVITY ...Analog Computer Applications, Geophysical Equipment, Gravity Studies, Navigation, Ships and Cruises, Technique Development, ...**7.0128**

INSTRUMENT DEVELOPMENT ...Navigation, Oxygen, Technique Development, ...**8.0065**

VLF/OMEGA NAVIGATION ...Communication & Navigation, Control-systems, Navigation, Navigation Communication, ...**4.0106**

AIR OCEANOGRAPHY ...Air-sea Boundary-general, Atlantic Ocean-north, Buoys, Gulf Stream, Technique Development, ...**4.0163**

SATELLITE COMMUNICATION TESTS ...Buoys, Forecasting-prediction, Marine Environments-general, Telemetry-other, Very High Frequency, ...**4.0001**

REMOTE SENSOR OCEANOGRAPHY ...Aerial Photography, Cloud Temperature, Gulf of Mexico, Infrared Radiation, Surface Environments, Temperature, ...4.0170

SPACECRAFT OCEANOGRAPHY ...Instrumentation, Instrumentation-general, Management, Photography, Unmanned Satelite, ...4.0157

AIRBORNE REMOTE SENSING OCEANOGRAPHY PROJECT ...Aircraft, Data Acquisition, Instrumental Services, Photography, Radar, ...4.0155

EXPERIMENTAL SEA ICE OBSERVATIONAL TECHNIQUES ...Data Acquisition, Imaging, Instrumental Services, Range and Tracking-other, Sea Ice, ...4.0156

COORDINATION OF ESTUARINE REMOTE SENSING IN ATLANTIC COAST REGION ...Aerial Photography, Atlantic Ocean-general, Estuaries, ...4.0169

EVALUATION OF CONTEMPORARY PRECISION NAVIGATION SYSTEMS ...Bathymetry, Communication & Navigation, Navigation, Navigation Communication, Technique Development, ...4.0087

SPACE APPLICATIONS TO FISHERIES OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM) ...Commercial Fishing, Computer Applications, Forecasting-prediction, Water Environment -other, ...4.0172

Spacecraft Sensory Devices

FISHERIES OCEANOGRAPHY AND ENVIRONMENTAL ASSESSMENT AND PREDICTION ...Commercial Fishing, Convection, Oceanography-general, Thermal, ...4.0150

REMOTE SENSOR SYSTEMS INTERGRATION AND PRESENT OPERATIONS DESCRIPTION ...Commercial Fishing, Fish -non-specific, Remote Sensing -other, Spectral Reflectance, ...4.0154

Spectral Reflectance

FISHERIES RESOURCES IDENTIFICATION AND ASSESSMENT ...Aerial Photography, Behavioral Ecology, Commercial Fishing, Fish -non-specific, Optical, ...4.0149

SPECTRAL SIGNATURES OF FISH SCHOOL IDENTIFICATION ...Atomic Absorption, Fish -non-specific, Oil, Oils -fats, ...4.0151

FLIGHT TESTING OF HIGH PERFORMANCE WIDE-RANGE IMAGE SPECTROPHOTOMETER (WISP) SYSTEM ...Aircraft, Optical, Technique Development, ...4.0152

REMOTE SENSOR SYSTEMS INTERGRATION AND PRESENT OPERATIONS DESCRIPTION ...Commercial Fishing, Fish -non-specific, Remote Sensing -other, Spacecraft Sensory Devices, ...4.0154

DETECTION AND CLASSIFICATION OF FISH AND MINERAL OIL SLICKS BY REMOTE SENSING FROM ORBITAL ALTITUDE ...Fish -non-specific, Oil, Oils -fats, Ultra - Violet Radiation, ...4.0140

PACIFIC COASTAL ENVIRONMENT AS RELATED TO DISTRIBUTION AND ABUNDANCE OF GAME SPECIES -- SEA SURFACE TEMPERATURE MEASUREMENTS ...Aquatic Ecology, California, Temperature, ...1.0175

Ultra - Violet Radiation

DETECTION AND CLASSIFICATION OF FISH AND MINERAL OIL SLICKS BY REMOTE SENSING FROM ORBITAL ALTITUDE ...Fish -non-specific, Oil, Oils -fats, Spectral Reflectance, ...4.0140

ULTRAVIOLET ABSORPTION IN COASTAL WATERS ...Biological, Marine Plants, Physical Parameters, Plant Prod. (non-specific), Sewage, Total Organic Carbon, ...6.0138

Visible Light

REMOTE SENSING, EVERGLADES AREA, FLORIDA ...Computer Applications, Florida, Remote Areas, Swamps-marshes, Water Properties-general, ...4.0161

Reproduction

Artifical Insemination

CRYOGENIC PRESERVATION OF VIABLE FISH SPERM ...Cellular Physiology, Fish -non-specific, Freezing Techniques, Male Gametes, ...5.0303

LIFE HISTORY OF CLUPEA HARENGUS PALLASI ...Alewife,menhaden,shad,herring, Aquaculture & Fish-farming, Life History Studies, Water Salinity, Water Temperature-nonspecific, ...5.0035

INVESTIGATE SYSTEMATICS AND ECOLOGY OF TUNA LARVAE AND JUVENILES ...Animal Taxonomy, Maturity & Growth Stages, Spawning & Nesting Sites, Tuna, Mackerel, Albacore... , ...5.0079

Gametes

Female Gametes

PHARMACOLOGY AND CHEMISTRY OF TOXIC MARINE ANIMALS ...Animal Toxins, Sculpins, Toxicology, ...6.0104

REPRODUCTION AND FECUNDITY OF TUNAS ...Behavior, Biological Rhythms, Fertility, Tuna, Mackerel, Albacore... , ...4.0159

ARTIFICIAL SELECTION - FISH ...Fish -non-specific, Genetic Resistance, Pesticides -non-specific, Pollution - Effects of , Selection & Breeding, ...5.0256

Male Gametes

FERTILIZATION MECHANISMS AND GAMETE PHYSIOLOGY IN MARINE INVERTEBRATES ...Basic Embryology, Metabolism, Reproductive System, Sea Urchins & Other Echinoderm, ...5.0590

CRYOGENIC PRESERVATION OF VIABLE FISH SPERM ...Artifical Insemination, Cellular Physiology, Fish -non-specific, Freezing Techniques, ...5.0303

THE ROLE OF CALCIUM IONS IN THE MOTILITY OF SEA URCHIN AND OTHER SPERMATOZOA ...Atpase, Calcium, Motility and Migration, Yellow Perch, Darters, ...5.0622

CRYOGENIC PRESERVATION OF VIABLE FISH SPERM ...Fertility, Fish -non-specific, Freezing Techniques, Rapid Freeze, ...5.0310

Parturition

BREEDING AND MATERNAL BEHAVIOR AMONG THE STELLER SEA LION ...Behavior, Developmental Physiology, Seals, Spawning & Nesting Sites, ...5.0524

Pregnancy

Fertilization

BIOCHEMISTRY OF FERTILIZATION AND EARLY DEVELOPMENT ...Basic Embryology, Reproductive System, Sea Urchins & Other Echinoderm, Vertebrates -non-specific, ...5.0550

Reproduction Studies (general)

EVOLUTION OF ALL-FEMALE FISHES ...Female , Gambusia, Molly, Other, ...5.0247

THE EVOLUTION AND CAUSATION OF SOCIAL BEHAVIOR IN ANABANTOID FISHES ...Behavior, Ethological, Fish - other, Social Behavior, ...5.0300

SEAL BIOLOGY AND HARVEST ...Alaska, Environmental Ecology, Interbiotic Relat.(non-specif), Life History Studies, Seals, ...5.0522

WALRUS BIOLOGY AND POPULATION ...Behavioral Ecology, Censusing, Migration, Population Dynamics, Seals, ...5.0523

WATER QUALITY AS RELATED TO SURVIVAL OF SALMON EGGS AND LARVAE ...Environmental Ecology, Mortality Rates, Salmon & Trout - Non-specific, Spawning & Nesting Sites, Water Quality-general, ...5.0227

REPRODUCTIVE ISOLATING MECHANISMS IN PANAMANIAN INSHORE MARINE FISHES ...Behavioral Ecology, Comparative Physiology, Fish -non-specific, Panama, ...5.0244

HEMOGLOBIN VARIATIONS AS INDICATORS OF BLUEFISH RACES ...Animal Taxonomy, Bluefish, Hemoglobin, Polymorphism, ...5.0320

ADMINISTRATION OF WHALING ACT, COMMERCIALLY UTILIZED WHALES ...Age, Food Supply, Growth Rate, Mammals, Parasitology -other, ...5.0668

ADMINISTRATION OF WHALING ACT, PROTECTED AND NON-COMMERCIAL WHALES ...Censusing, Growth Rate, Mammals, Migration, Vertebrate Anatomy, ...5.0669

Reproductive System Male

Testes

STUDIES OF FISH ENDOCRINOLOGY ...Environmental Physiology, Fresh Water, Hormone, Killifishs - Cyprinodon, Thyroid, ...5.0246

Reptiles

Snakes

VENOMOUS FISHES AND SEA SNAKES OF SOUTHEAST ASIA ...Behavior, Fish -non-specific, Southeast Asia, Venom, Vertebrate Anatomy, ...6.0101

THE MORPHOLOGY, HISTOCHEMISTRY, AND MODE OF SECRETION IN THE VENOM GLAND OF SEA SNAKES ...Endocrine -other, Histochemistry - Cytochem, Venom, Vertebrate Anatomy, ...5.0529

Turtles, Terrapins, Tortoises

THE ECOLOGY, MIGRATIONS AND BEHAVIOR OF MARINE TURTLES ...Behavioral Ecology, Migration, Reptile Studies -other, Spawning & Nesting Sites, ...5.0586

ORIENTATION CUES AND PATTERNS OF LONG-DISTANCE TRAVEL OF MARINE TURTLES ...Biological Rhythms, Environmental Physiology, Migration, Orientation, ...4.0102

THE SPECTRAL SENSITIVITY OF THE GREEN SEA TURTLE (CHELONIA MYDAS) ...Light Quality -non-specific, Visual Organs, ...5.0560

Reservoirs and Impoundments

INVESTIGATE THE FEASIBILITY OF INTRODUCING SOCKEYE SALMON INTO RESERVOIRS ...Aquatic Ecology, Captive Rearing, Oregon, Salmon -coho,chinook,sockeye.., Stocking of Fish & Shellfish, ...5.0141

PREDICTION OF ENVIRONMENT ...Biological-general, Columbia River, Environmental Ecology, Low Temp. -but Above 32f, Physical-general, Salmon & Trout - Non-specific, Snake River, Temperature, Thermal Pollution, ...5.0225

Residue Analysis

Bioassay

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...Estuaries, Persistance of Residues, Pollution - Effects of , Sevin, Swamps-marshes, ...5.0918

EXPLORATORY COLLECTION AND CARE OF FISH FOR TESTING AT TIBURON ...California, Fish -non-specific, Laboratory Animals, San Francisco Bay, ...5.0116

EXPLORATORY COLLECTION AND CARE OF AQUATIC INVERTEBRATES FOR TESTING AT TIBURON ...Brackish Water, Captive Rearing, Invertebrates -non-specific, Pesticides -non-specific, ...5.0905

PESTICIDES ...Aquatic Or Soil-aquatic Cycles, Fish, Persistance of Residues, Pesticides -non-specific, Pollution Effects, ...5.0881

RATE OF ABSORPTION OF ENDRIN BY BLUEGILL SUNFISH ..Bluegills, Bream, DDT , Endrin, Metabolism, Mode of Action -animal, ...5.0263

Monitoring Systems

PESTICIDE MONITORING PROGRAM ...Bioindicators, Estuaries, Gas Chromatography, Oysters, Persistance of Residues, ...6.0147

MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES ...Fish -non-specific, Great Lakes-general, Insecticides -non-specific, Pollutants-general, Sampling, ...6.0120

Resistance & Tolerance

Animal Resistance

Animal Resistance -other

PESTICIDE RESISTANT FISH IN NATURAL ECOSYSTEMS ...Endrin, Fish, Food Chains, Animal And/or Man, Pollution Effects, Rates, Doses, Concentrations, ...5.0277

Genetic Resistance

ARTIFICIAL SELECTION - FISH ...Female Gametes, Fish -non-specific, Pesticides -non-specific, Pollution - Effects of , Selection & Breeding, ...5.0256

Respiratory System

Function, Biochemistry

Control and Regulation

CARDIOVASCULAR STUDIES ON DIVING MAMMALS ...Adaptation, Basic Hemodynamics, Cardiovascular System, Heart, Locomotion -animal, Seals, ...5.0639

Diffusion of Gases

DIVING MEDICINE ...Divers, Diving and Scuba, Occupational Hazards, Pressure, ...8.0017

Liquid-breathing

MANNED DIVING RESEARCH ...Decompression Sickness, Divers, Diving and Scuba, Medical Studies, ...6.0096

Mechanics, Compliance

COMPARATIVE PHYSIOLOGY OF RESPIRATORY MECHANICS IN MAMMALS ...Comparative Physiology, Mammals, ...5.0612

Rhode Island

SYMPOSIUM ON THE MINERAL RESOURCES OF THE WORLD OCEAN ...Engineering Studies-general, Meetings, Ocean Mining, Policy Making, ...7.0027

THE RHODE ISLAND HARD CLAM - QUAHAUG - INDUSTRY ...Clams, Costs, Fish & Shellfish, Production & Processing, ...5.0493

FINANCING OF FISHING VESSELS ...Commercial Fishing, Economics, Fish & Shellfish, Savings and Investment, ...4.0185

SOCIO-ECONOMIC STUDY OF NARRAGANSETT BAY, RHODE ISLAND ...Bays, Benefit-cost Analysis, Estuaries, Land Use, Social Aspects, Water Quality Control-general, ...9.0019

SHALLOW WATER OCEANOGRAPHY ...Acoustical, Continental Shelf, Hydrodynamics, Surface Environments, Transmission, ...1.0030

Rickettsia

Neorickettsiae Helmint

NATURAL HISTORY OF SALMON POISONING RICKETTSIAE ...Flukes, Helminths, Invertebrates, Reservoirs, ...5.0842

EPIDEMIOLOGY OF SALMON POISONING DISEASE ...Flukes, Helminths, Pathology, Salmon & Trout - Non-specific, Virulence and Pathogenicity, ...5.0307

RNA

DYNAMICS OF OCEANIC PLANKTON ...Growth Rate, Number Or Density, Productivity (agricultural), Zooplankton, ...5.0825

ANTIGEN DISTRIBUTION OF DEVELOPING SEA URCHIN EMBRYOS ...Antigen, Basic Embryology, Immunity, Interspecific Genetic Relat. , Sea Urchins & Other Echinoderm, ...5.0585

Messenger RNA

BIOSYNTHETIC PROCESSES DURING DEVELOPMENT OF SEA URCHIN EGGS ...Basic Embryology, Cell Cycle, Nucleic Acids, Proteins, Sea Urchins & Other Echinoderm, ...5.0775

PHYSIOLOGY OF FERTILIZATION AND NUCLEO-CYTOPLASMIC INTERACTIONS IN SEA URCHIN DEVELOPMENT ...Basic Embryology, Nucleus (non-specific & Ot.), Reproductive System, Sea Urchins & Other Echinoderm, Selection & Breeding, ...5.0673

BIOCHEMISTRY OF DEVELOPMENT ...Basic Embryology, Control and Regulation, Differentiation Mechanism, Sea Urchins & Other Echinoderm, Tryptophan Oxidase, ...5.0994

SYMBIOSIS OF TROPICAL ZOANTHIDEA AND ZOOXANTHELLAE ...Anthozoa, Metabolism, Symbiosis, Tropic, Zooxanthella, ...5.0642

Rocks - Bedrock

GEOLOGICAL STUDIES IN NORTHERN LAKE MICHIGAN ...Deposits-other, Lake Michigan, Lakes, Submergent, Water Level Fluctuation, ...7.0164

STRONTIUM ISOTOPE COMPOSITION AND TRACE ELEMENT CONCENTRATIONS IN LAKE HURON AND ITS PRINCIPAL TRIBUTARIES ...Chemical, Ions and Gases, Lake Huron, Strontium, Trace Element Analysis, ...1.0124

Runoff

ANALYSIS OF SEA WATER BY DIFFERENCE CHROMATOGRAPHY ...Interstitial - Connate Water, Ion Exchange, Salinity, Water Analysis-general, ...1.0110

EXTENT OF BRACKISH WATER IN TIDAL RIVERS, MARYLAND ...Brackish Water, Tides, Water Utilization -general, ...1.0100

Russia

ARCTIC FIELD RESEARCH ...Arctic Ocean, Bibliography, Environmental Effects-geologic, Geophysics-general, ...11.0011

Safety

CHEMICAL EXPLOSIONS, PACKAGING AND HANDLING AT SEA ...Ammonia, Durability, Deterioration, Explosions, Detonation, Packaging, ...8.0130

NITROGEN-OXYGEN DECOMPRESSION TABLES FOR ALTITUDE FLIGHT ...Decompression Sickness, Diving, Manned Satelite, Space Medicine, Tables, Compilations, Catalogs, ...6.0099

HYDROGEN-OXYGEN FUEL CELLS ...Encapsulation, Fuel Cell-other, Gas Generator, Oxidants, Submersibles, ...8.0160

Salt

STUDIES OF PROTEINS UNDER EXTREME ENVIRONMENTS ...Cellular Membranes (non-spec.), Cytochromes, Exobiology, Halobacteria, Respiration, ...5.0941

WATER AND SALT REGULATION IN NEREID POLYCHAETES ...Active Transport, Comparative Physiology, Lugworm, Marine Segmentedworm, Osmoregulation, ...5.0648

Sampling

(A) ANNUAL SUPPLY OF PARTICULATE MATTER IN THE GREAT BAY ESTUARY (B) LATE PLEISTOCENE HISTORY OF THE GREAT ...Estuaries, New Hampshire, Organics, Quaternary Period, Sedimentary History, ...1.0155

DATA COLLECTION ...Charts, Data Acquisition, Data Analysis - General, Instrumentation-general, ...4.0017

CIRCULATION OF THE PACIFIC ...Circulation-general, Density, Oceanic Fronts, Pacific Ocean-general, Subsurface Environments, ...2.0007

DEEP-SEA AUTONOMOUS VEHICLES, INSTRUMENTS, BASIC CONTROL DEVICES, AND SPECIAL COLLECTING GEAR ...Abyssal, Bottom Sampling Device, Organism Sampling Devices, Photography, Submersibles, Water Motion Recorders, ...8.0122

WATER MASSES, CURRENTS AND ORIGIN OF THE ATLANTIC BOTTOM WATER IN THE WEDDEL SEA, ANTARCTICA ...Currents-bottom, Depth, Oceanic Fronts, Salinity, Temperature, Weddell Sea, ...4.0134

TRITIUM IN HURRICANES ...Air Pollution Sampling, Atlantic Ocean-general, Particle-gas Transfer, Tritium, Tropical Cyclones, ...3.0018

CONTRACT FOR-PROCESSING OF USARP ROCK SAMPLES ...Antarctica, Classifications, Collections, Coring and Dredging, Petrology, Ships and Cruises, Thin Sections, ...7.0060

DISTRIBUTION OF CARBON AND RADIUM IN THE ANTARCTIC WATERS ...Carbon, Gases, Indian Ocean-general, Radium, Trace Elements, ...1.0109

PROPERTIES AND ORIGIN OF SEDIMENTS ON THE CONTINENTAL MARGIN OFF WESTERN U. S. ...Erosion, Origin, Physical Properties, Sedimentation, Shoreline - Coastline, ...7.0271

HOLOGRAPHIC STUDIES OF MARINE ORGANISMS ...Acoustical, Holography, Lasers-masers, Plankton (non-specific), Plant Prod. (non-specific), ...8.0060

ORGANIC MATTER ...Atlantic Ocean-general, Mixing, Oceanic Fronts, Organics, Oxygen, Ships and Cruises, ...1.0111

USES OF STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN FOR EFFICIENT COLLECTION OF OCEAN DATA ...Data & Statistics Storage, Information Retrieval Methods, ...4.0015

STABLE ISOTOPES ...Atlantic Ocean-north, Atlantic Ocean-south, Carbon, Chemical Analysis (water), Water Chemistry-other, ...1.0108

MARINE INTERFACE CHEMISTRY ...Air-sea Boundary-general, General Sea Water Chemistry, Organics, ...1.0073

MARINE RADIOLOGICAL INSTRUMENTATION ...Acoustical, Chemical Analysis (water), Circulation-general, Laboratory Analysis, Mixing, Radioactivity-general, ...8.0062

A STUDY OF COLIFORM BACTERIA AND ESCHERICHIA COLI ON POLLUTED AND UNPOLLUTED OYSTER BOTTOMS OF MISSISSIPPI ...Coliforms (non-specific), Identification, Mississippi River, Sewage, Vertical Distribution, ...5.0465

FARMINGTON RIVER SHAD STUDIES ...Alewife,menhaden,shad,herring, Bottom Sampling, Captive Rearing, Migration, Streams, ...5.0203

RADIOISOTOPE TRACERS IN OCEANOGRAPHIC RESEARCH ...Circulation-general, Radioactivity-general, Trace Elements, Tracers, ...2.0001

ISOTOPIC OCEANOGRAPHY ...Arctic Ocean, Data Acquisition, Oceans - Sea Water, Radioactivity-general, Trace Elements, ...1.0090

AMBIENT SEA NOISE ...Acoustical, Buoys, Noise, Sound Production, ...1.0013

SALT-WATER ENCROACHMENT IN NORTH CAROLINA ESTUARIES ...Chemical-general, Estuaries, Flow Characteristics -water, Industrial-general, Saline Water Intrusion, ...6.0168

ROUTINE SAMPLING AT SEVEN INDEX STATIONS ...Bottom Sampling, Data Acquisition, Fish -non-specific, Lake Erie, Plankton Sampling, ...5.0214

MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES ...Fish -non-specific, Great Lakes-general, Insecticides - non-specific, Monitoring Systems, Pollutants-general, ...6.0120

TIME-SERIES OBSERVATIONS OF TEMPERATURE AND SALINITY (NORTH ATLANTIC AND NORTH PACIFIC OCEAN STATIONS) ...Atlantic Ocean-north, Depth, Pacific Ocean-north, Salinity, Temperature, ...4.0005

San Francisco Bay

EFFECTS OF WATER POLLUTION IN SAN FRANCISCO BAY ...Bays, Economic Impact, Pollution - Effects of , Recreation Sites, Social Aspects, Water Utilization -domestic, Welfare Economics, ...6.0140

EARTHQUAKE HAZARD - A PUBLIC POLICY PROBLEM IN THE SAN FRANCISCO BAY AREA ...California, Earthquakes, Faults, Forecasting-prediction, Intergovernmental Relations, Policy Making, ...9.0002

MARINE GEOLOGY OF THE SAN FRANCISCO BAY ...Bays, Geology-general, Gold, Mechanical Properties, Structural Studies, Tectogenesis, ...7.0035

GEOCHEMISTRY OF SAN FRANCISCO BAY ...Bays, Clays, Distribution, Mineral Associations, Trace Element Analysis, ...1.0074

EXPLORATORY COLLECTION AND CARE OF FISH FOR TESTING AT TIBURON ...Bioassay, California, Fish -non-specific, Laboratory Animals, ...5.0116

Sanitation

BACTERIAL INDICATORS OF THE SANITARY QUALITY OF DEPURATED HARD CLAMS, MERCENARIA MERCENARIA ...Clams, Food Spoilage Detection, Microbiological, ...6.0056

ENTEROVIRUSES IN DEPURATED HARD CLAMS, MERCENARIA MERCENARIA ...Clams, Detection, Enteroviruses of Humans, Microbiological Analysis, ...6.0057

EVALUATION OF PARAMETERS OF OPERATION ...Clams, ...6.0058

QUALITY STANDARDS TO DETERMINE RELEASE OF SHELLFISH FOR MARKETING PURPOSES ...Clams, Legal Standards, Microbiological, Shelf Life & Storage, ...6.0166

EFFECT OF PROCESS ON SHELLFISH ...Clams, Processed Product Quality, Processing, Shelf Life & Storage, Winter, ...6.0059

MICROBIOLOGY OF ESTUARINE AND SHELLFISH POLLUTION ...Bioindicators, Clams, Estuaries, Oysters, Pollution Effects, Waste Water Treatment-general, ...6.0162

Sargasso Sea

DEEP-WATER ZOOPLANKTON OF THE SARGASSO SEA ...Abyssal, Bermuda, Vertical Distribution, Zooplankton, ...5.0738

Scouring

SHOALING PROCESSES ...Channels, Sand Bars, Sediment Transport-other, Tidewater Areas, Turbulent Flow, ...7.0250

Screening Potential Pesticides

TOXICANT TOLERANCE STUDIES-SCREENING OF PESTICIDES AND FISH AT TIBURON ...California , Fish -non-specific, Laboratory Animals, Pesticides -non-specific, ...5.0278

TOXICANT TOLERANCE STUDIES - SCREENING OF PESTICIDES AND AQUATIC INVERTEBRATES AT TIBURON ...California, Herbicides -non-specific, Insecticides -non-specific, Laboratory Animals, ...5.0906

Sea Ice

SYSTEMS ANALYSIS ASSISTANCE TO HEADQUATERS U. S. COAST GUARD ...Benefit-cost Analysis, Model Studies, Ships and Cruises, Systems Analysis, ...12.0015

SATELLITE SEA ICE STUDIES USING HRIR ...Arctic Ocean, Data Analysis - General, Infrared Radiation, Satellites, Technique Development, ...3.0075

ARCTIC AIR, SEA AND ICE ...Arctic, Climatography, Heat and Radiation Transfer, Heat Exchange, Micrometeorology, Weather Forecasting, ...3.0088

ELECTRICAL PROPERTIES OF ICE ...Audio Frequency, Electrical, Phase Relationships, ...3.0072

ARCTIC RESEARCH ...Acoustical, Arctic Ocean, Currents-ocean, Geomorphology-topography, Magnetic Studies, ...4.0049

LARGE-SCALE INERTIAL OCEAN-ATMOSPHERE RELATIONSHIPS ...Air-sea Boundary-general, Greenland Sea, Jet Streams, Patterns, Sea of Okhotsk, Weather Forecasting, ...3.0024

EXCHANGE METEOROLOGIST WITH JAPANESE ANTARCTIC RESEARCH EXPEDITION ...Air-sea Boundary-general, Antarctic Ocean, General Synoptic Observations, Mixing, Radiosonde, ...3.0013

SPECIALIZED RESEARCH EQUIPMENT FOR SEA ICE STUDIES ...Alteration, Equipment Purchase Operation, ...3.0086

DISTRIBUTIONS OF CURRENTS AND PHYSICAL PROPERTIES WITHIN THE ARCTIC OCEAN ...Acoustical, Arctic Ocean, Currents-ocean, Heat and Radiation Transfer, Temperature, ...4.0051

SEA ICE MOVEMENT DYNAMICS ...Charts, Forecasting-prediction, Mapping, Model Studies, Polar, ...3.0087

ARCTIC SUB-ICE STUDY ...Acoustical, Arctic Ocean, Marine Biology, Submersibles, ...3.0074

HF AUDIO ABSORPTION IN ICE ...Acoustical, Attenuation, Ice Acoustics, Reverberation, Salinity, ...3.0073

DRIFT-STATION BIOLOGY ...Alaska, Animal Taxonomy, Arctic Ocean, Oceanic Fronts, Productivity - Food Chain, ...5.0743

ENVIRONMENTAL APPLICATIONS OF PASSIVE MICROWAVE SENSORS ...Beaches, Ice-general, Microwave Radiation, Sedimentology-general, Snow-general, Soil Engineering Investigation, ...4.0136

ARCTIC ADVISORY SERVICE ...Arctic Ocean, Bibliography, Ice Properties-general, Library, ...11.0012

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DISTRIBUTION OF ANTARCTIC MARINE FUNGI ...Antarctica, Marine Fungi (non-specific), Phycomycetes, Plant Taxonomy, Range Or Territorial Distr. , Vertical Distribution, ...5.0694

OPERATION OF R/V TRIDENT ...Geomorphology-topography, Phytoplankton, Sea Floor Spreading, Sound Production, Subbottom, Vertical Distribution, ...12.0045

SUPPORT FOR THE OPERATION OF OCEANOGRAPHIC RESEARCH VESSELS ...Black Sea, Marine Biology, Mediterranean Sea-general, Sedimentation, Water Analysis-general, ...11.0030

SHIPBOARD WORK ABOARD THE OCEANOGRAPHER ...Microfossils, Travel Grants, ...11.0004

RESEARCH VESSEL OPERATIONS ...Continental Shelves, Facilities, Oceanography-general, Oregon, Pacific Ocean-east, ...12.0041

OCEANOGRAPHIC VESSEL OPERATIONS ...Equipment Purchase Operation, Geology-general, Pacific Ocean-north, Plankton (non-specific), Plant Prod. (non-specific), ...12.0047

SUPPORT OF RESEARCH VESSEL AT LAMONT GEOLOGICAL OBSERVATORY ...Distribution, Marine Biology, Patterns, Ridges, Seismic Studies, ...12.0037

OPERATION OF R/V ALAMINOS ...Carbon, Caribbean Sea, Gulf of Mexico, Gulf Stream, Textures-structures, ...12.0046

GULF STREAM TRANSPORT ...Automatic Stations, Gulf Stream, Hydrodynamics, Water Motion Recorders, ...2.0029

TRANSPORTATION EXPENSES FOR PARTICIPATION IN USC&GSS OCEANOGRAPHER GLOBAL EXPEDITION ...Expeditions, Oceanography-general, Travel Grants, ...12.0038

SUPPORT OF TWO RESEARCH VESSELS ...Air-sea Boundary-general, General Sea Water Chemistry, Great Lakes-general, Marine Biology, Water Properties-general, ...12.0034

MARINE GRAVITY ...Analog Computer Applications, Geophysical Equipment, Gravity Studies, Navigation, Satellites, Technique Development, ...7.0128

PARTICIPATION IN USARP EXPEDITIONS ...Antarctica, Data Acquisition, Data Analysis - General, Marine Biology, Teaching and Research, ...12.0012

CONTRACT FOR-PROCESSING OF USARP ROCK SAMPLES ...Antarctica, Classifications, Collections, Coring and Dredging, Petrology, Sampling, Thin Sections, ...7.0060

OPERATION OF THE R/V HERO AND PALMER STATION SUPPORT LABORATORY ...Antarctica, Facilities, Marine Biology (non-specific), ...12.0023

PLANKTON ECOLOGY ...Aquatic Ecology, Copepods, Lake Michigan, Plankton Sampling, Zooplankton, ...5.0803

PREDICTION OF BIOLOGICAL POPULATIONS FROM THE PHYSICAL OCEANIC ENVIRONMENT ...Marine Environments-general, Phytoplankton, Range Or Territorial Distr. , Temporal Distribution, Vertical Distribution, ...5.0844

ORGANIC MATTER ...Atlantic Ocean-general, Mixing, Oceanic Fronts, Organics, Oxygen, Sampling, ...1.0111

MARINE GRAVITY ...Dynamic Gravimeters, Geophysical Equipment, Navigation, Technique Development, ...8.0101

MEDITERRANEAN OCEANOGRAPHY ...Convection, Data Analysis - General, Heat and Radiation Transfer, Mediterranean Sea-general, Surface Environments, ...4.0132

GRAVITY FIELD AT SEA ...Gravity Studies, Navigation, Pacific Ocean-south, Variations, ...7.0098

HUDSON LABORATORIES SHIP SUPPORT ...Acoustical, Facilities, Modification-conversion, Platforms, Scientific-service-support, Special Mission Ships, ...12.0021

MODEL FOR THE PRELIMINARY DESIGN OF SURFACE EFFECT SHIPS ...Computer Applications, Drag, Hydrofoils Crafts, Marine Propulsion, Other Models, Waves, ...8.0279

ENVIRONMENTAL SUPPORT OF SONAR DESIGN ...Acoustical, Liquids, Model Studies, Transmission, Water Properties-general, ...1.0015

PRELIMINARY STUDIES TO CORRELATE SELECTED MINERALOGIC AND GEOLOGIC PROPERTIES WITH ENGINEERING PROPERTIES ...Alaska, Engineering Geology, Mineralogy, Petrology, Trace Element Analysis, ...8.0169

DISTRIBUTION OF YOUNG STAGES OF COASTAL FISHES ...Continental Shelf, Estuaries, Fish -non-specific, Maturity & Growth Stages, Number Or Density, ...5.0119

ENVIRONMENTAL EFFECTS ON ISTIOPHORID FISH DISTRIBUTION ...Environmental Ecology, Gulf of Mexico, Marlin, Billfishes, Sailfish.., Temporal Distribution, ...5.0070

EASTERN TROPICAL PACIFIC COOPERATIVE SURVEY ...Bathythermographs, Mapping, Pacific Ocean-east, ...4.0122

OCEANOGRAPHIC STUDY OF NORTHEASTERN U. S. COASTAL WATERS FOR INTERNATIONAL COMMISSION FOR NORTHWEST ATLANTIC FISHERIES ...Commercial Fishing, Gases, Salinity, Temperature, ...4.0123

Shoals

VISIBLE REGION INSTRUMENTATION FOR OCEANOGRAPHIC SATELLITES ...Currents-ocean, Geomorphology-topography, Mapping, Photography, Satellites, ...8.0088

MODEL STUDIES OF REFRACTION OF SHOALING OCEAN WAVES ...Forecasting-prediction, Model Apparatus-other, Model Studies, Wave, Waves, ...8.0194

SHALLOW WATER PROPAGATION ...Acoustical, Coherence, Reverberation, Transmission, Water Properties-general, ...1.0035

Shoreline - Coastline

AN EXPERIMENTAL AND THEORETICAL STUDY OF THE MARINE AND CONTINENTAL CLIMATES OF POINT CONCEPTION TO THE MORRO BAY REGION OF CALIFORNIA ...California, General Synoptic Observations, Micrometeorology, Military Aspects, ...3.0055

SIMULATION MODELS OF SHALLOW-WATER AND COASTAL ENVIRONMENTS ...Computer Applications, Gulf of Mexico, Hydrology-general, Model Studies, Sedimentation, ...4.0066

GENERATION, PROPAGATION, AND COASTAL EFFECTS OF TSUNAMIS ...Earthquakes, Harbors, Propagation, Shoreline Structures, Tsunami, ...2.0095

RECENT MARINE AND NONMARINE SEDIMENTS AND MICROFAUNA OF DELAWARE COASTAL AREAS ...Bays, Delaware, Facies, Paleoenvironments, Quaternary Period, Sedimentary Structure-general, ...7.0207

LENGTHENING AND INCREASING OCEANOGRAPHIC CAPABILITES OF R/V ACONA ...Equipment Purchase Operation, Modification-conversion, Oceanography-general, Pacific Ocean-north, Special Mission Ships, ...12.0002

COMPARISON OF ANCIENT AND MODERN COASTAL CLASTIC SEDIMENTARY ENVIRONMENTS ...Cretaceous Period, Environment, Quaternary Period, Textures-structures, Water Deposited Clastics, ...7.0234

PROPERTIES AND ORIGIN OF SEDIMENTS ON THE CONTINENTAL MARGIN OFF WESTERN U. S. ...Erosion, Origin, Physical Properties, Sampling, Sedimentation, ...7.0271

OCEANOGRAPHIC PROCESSES IN ESTUARINE AND COASTAL WATERS ...Oceanic Fronts, Pacific Ocean-east, Puget Sound, Washington, Water Properties-general, ...4.0050

CARIBBEAN GEOGRAPHY ...Beach, Caribbean Sea, Central America, Shore Features-general, South America, ...7.0288

MULTISPECTRAL SENSING OF COASTAL ENVIRONMENTS ...Aerial Photography, Beaches, Depth, E M Radiation-general, Geomorphology-topography, Photography, ...4.0166

COASTAL MORPHOLOGY ...Beach, Deltas, Development, General Information Services, Shore Features-general, Tropic, ...7.0297

REGIONAL COASTAL CHANGE ...Development, Environmental Changes, Quaternary Period, ...7.0301

NEARSHORE WAVE THEORY ...Development, Model Studies, Sediment Transport-general, Waves, ...2.0119

UTILIZATION OF PHYSICAL AND MATHEMATICAL MODELS IN MARINE WATER RESOURCES RESEARCH AND MANAGEMENT ...Environmental Effects-geologic, Estuaries, Management, Mathematical Analysis, Model Studies, ...4.0084

DISPERSION IN HYDROLOGIC AND COASTAL ENVIRONMENTS ...Dispersion -water, Groundwater Movement, Ocean, Stratified Flow, Turbulent Flow, ...2.0051

ORGANIC DEBRIS ON CONNECTICUT BEACHES AND SHORES ...Catabolism and Degradation, Connecticut, Identification, Organic Matter, Physical-general, ...6.0143

A RECONNAISSANCE OF COASTAL EROSION IN NORTH CAROLINA ...Aerial Photography, Beach, Development, Erosional Features, North Carolina, Photogrammetry, Reconnaissance, Waves, ...7.0268

EVOLUTIONARY DEVELOPMENT OF CUSPATE FORELANDS ...Beach, Continental Shelf, Depositional Features-other, Deposits-other, Development, North Carolina, ...7.0296

COASTAL AND CONTINENTAL SHELF SEDIMENTATION ...Argentina, Continental Shelf, Distribution, Sediment Transport-other, Sedimentation, ...7.0212

INTERPRETING THE ORIGIN AND DISTRIBUTION OF COASTAL SEDIMENTS ...Canada, Distribution, Massachusetts, Origin, Size, ...7.0213

CHANGES IN SEA LEVEL IN NORTHERN TUNESIA ...Archeology, Sea Level Variations, Sedimentation, Tunisia, ...7.0208

STUDY OF EFFECTS OF OFFSHORE DUMPING ...Circulation-general, Dispersion -water, Engineering Studies-other, Pollution - Effects of , Pollution Sources-other, ...6.0144

COASTAL PROCESSES - SOUTH TEXAS ...Depositional Features-other, Distribution, Other Transport Methods, Rate of Deposition, Texas, ...7.0219

NORTHERN CALIFORNIA OFFSHORE BLACK SANDS ...California, Distribution, Heavy Minerals, Size, Terrigenous, ...7.0020

OREGON-WASHINGTON NEARSHORE ...Distribution, Heavy Minerals, Oregon, Terrigenous, Washington, ...7.0022

MARINE-FLUVIAL INTERFACE, COASTAL OREGON ...Development, Heavy Minerals, Oregon, Placer, Processes, Terrace-bench, ...7.0018

COASTAL AND INSHORE OCEANOGRAPHY ...Alaska, Estuaries, Marine Biology, Water Analysis-general, Water Properties-general, ...5.0851

DISPOSAL TO MARINE WATERS ...Circulation-general, Model Studies, Monitoring (long Term Studies), Pollution - Effects of , Pollution Sources-general, ...6.0177

Shoreline Structures

WAVE DAMPING SYSTEMS ...Breakwaters, Energy Dissipators, Model Studies, Wave Action, Waves, ...8.0047

GENERATION, PROPAGATION, AND COASTAL EFFECTS OF TSUNAMIS ...Earthquakes, Harbors, Propagation, Shoreline - Coastline, Tsunami, ...2.0095

DESIGN OF RUBBLE WAVE-ABSORBER ...Beaches, Energy Dissipators, Harbors, Measuring Devices-other, Waves, ...8.0037

WAVE FORCES ON BREAKWATERS ...Breakwaters, Hydrodynamics, Model Studies, Wave Action, Waves, ...8.0044

STUDY OF BEACH NOURISHMENT ALONG THE SOUTHERN CALIFORNIA COAST ...Beach, California, Erosional Features, Sediment Transport-general, Supply Rate, ...7.0292

WAVE FORCES ON BREAKWATERS ...Breakwaters, Ext Pressure on Struct-general, Wave Action, Waves, ...8.0234

STABILITY OF RUBBLE-MOUND BREAKWATERS ...Breakwaters, Design Criteria, Engineering Structures-general, Hydrodynamics, Wave Action, Waves, ...8.0045

WAVE ACTION ON STRUCTURES ...Engineering Structures-general, Hydrodynamic Structures, Models, Stability, Wave Action, Waves, ...8.0175

MECHANICS OF SAND MOVEMENT BY WAVES ...Model Studies, Ocean Waves - Currents, Size, Wave Motion in Fluids-other, Waves, ...7.0217

CORRELATION OF BEACH PROPERTIES AND INCIDENT WAVES ...Beach, Development, Engineering Structures-general, General Transport Effects, Sea Level Variations, Waves, ...8.0204

COASTAL WORKS EVALUATION FOR CHECKING, IMPROVING AND DEVELOPING DESIGN RELATIONSHIPS AND CONSTRUCTION TECHNIQUE ...Breakwaters, Coastal Engineering-other, Design Criteria, Groin, Jetty, ...8.0039

DEVELOPMENT OF OFFSHORE SOURCES OF SAND SUITABLE FOR BEACH RESTORATION AND NOURISHMENT ...Beach, Coring and Dredging, Mapping, Ocean Mining, Size, ...7.0012

METHODS OF BYPASSING SAND PAST INLETS ...By-passing, Coastal Engineering-other, Ocean Waves - Currents, Size, ...8.0040

DEVELOPMENT OF CRITERIA FOR ARTIFICIAL BEACHES ...Beach, Beaches, Coastal Engineering-other, Design Criteria, Statistics-general, ...8.0041

RUBBLE-MOUND PROTOTYPE STUDIES ...Breakwaters, Jetty, Water Motion Recorders, Wave Action, Waves, ...8.0042

Shorelines-geomorphic Studies

Classification

Emergent

MARINE GEOLOGY OF CONTINENTAL MARGINS ...Continental Shelves, Mexico, Quaternary Period, Regional Structure, Wave-built Terrace, ...7.0029

INVESTIGATION OF QUATERNARY SEA LEVEL CHANGES IN THE CAROLINE AND MARSHALL ISLANDS ...Carbon-14, Pacific Ocean-south, Quaternary Period, Reefs, Sea Level Variations, ...7.0159

Submergent

POTENTIALLY-ECONOMIC SAND AND SILT DEPOSITS IN LAKE ONTARIO, NEW YORK ...Geologic Maps, Lake Ontario, New York, Potential of Deposit, Sands and Gravels, ...7.0024

GEOLOGICAL STUDIES IN NORTHERN LAKE MICHIGAN ...Deposits-other, Lake Michigan, Lakes, Rocks - Bedrock, Water Level Fluctuation, ...7.0164

SUBSURFACE GEOLOGY OF HOGSTY REEF, AN ATOLL IN THE SOUTHEASTERN BAHAMAS ...Atolls, British West Indies, Paleoenvironments, Physiographic History, Quaternary Period, Subsurface, ...7.0037

SEWARD PENINSULA NEARSHORE ...Bering Sea, Heavy Minerals, Potential of Deposit, Sea Level Changes, Tectonics-general, ...7.0017

Depositional Features

Beach

SAND TRANSPORT ...Ocean Waves - Currents, Sand Bars, Sedimentation, Submarine Canyons, Textures-structures, ...7.0202

A STUDY OF THE ECOLOGY OF THE MICROFAUNA LIVING BETWEEN INTERTIDAL MARINE SEDIMENTS ...Copepods, Crustacea -non-specific, Intertidal Areas, New England Province, Salinity, ...5.0793

CARIBBEAN GEOGRAPHY ...Caribbean Sea, Central America, Shore Features-general, Shoreline - Coastline, South America, ...7.0288

COASTAL MORPHOLOGY ...Deltas, Development, General Information Services, Shore Features-general, Shoreline - Coastline, Tropic, ...7.0297

THE POTENTIAL SOURCE, TRANSPORT AND DEPOSITIONAL PATTERNS OF CLASTIC SEDIMENTS IN PORTIONS OF COASTAL GEORGIA ...Currents-longshore, General Mineralogic Properties, Georgia, Microstructure, Size, ...7.0235

STUDY OF BEACH NOURISHMENT ALONG THE SOUTHERN CALIFORNIA COAST ...California, Erosional Features, Sediment Transport-general, Shoreline Structures, Supply Rate, ...7.0292

A RECONNAISSANCE OF COASTAL EROSION IN NORTH CAROLINA ...Aerial Photography, Development, Erosional Features, North Carolina, Photogrammetry, Reconnaissance, Shoreline - Coastline, Waves, ...7.0268

EVOLUTIONARY DEVELOPMENT OF CUSPATE FORELANDS ...Continental Shelf, Depositional Features-other, Deposits-other, Development, North Carolina, Shoreline - Coastline, ...7.0296

GREAT LAKES RESEARCH - COASTAL AREA SEDIMENTATION ...Development, Energy, General Transport Effects, Great Lakes-general, Model Studies, Sedimentation, ...7.0124

CORRELATION OF BEACH PROPERTIES AND INCIDENT WAVES ...Development, Engineering Structures-general, General Transport Effects, Sea Level Variations, Shoreline Structures, Waves, ...8.0204

DEVELOPMENT OF OFFSHORE SOURCES OF SAND SUITABLE FOR BEACH RESTORATION AND NOURISHMENT ...Coring and Dredging, Mapping, Ocean Mining, Shoreline Structures, Size, ...7.0012

DEVELOPMENT OF CRITERIA FOR ARTIFICIAL BEACHES ...Beaches, Coastal Engineering-other, Design Criteria, Shoreline Structures, Statistics-general, ...8.0041

Depositional Features-other

EVOLUTIONARY DEVELOPMENT OF CUSPATE FORELANDS ...Beach, Continental Shelf, Deposits-other, Development, North Carolina, Shoreline - Coastline, ...7.0296

COASTAL PROCESSES - SOUTH TEXAS ...Distribution, Other Transport Methods, Rate of Deposition, Shoreline - Coastline, Texas, ...7.0219

Wave-built Terrace

MARINE GEOLOGY OF CONTINENTAL MARGINS ...Continental Shelves, Emergent, Mexico, Quaternary Period, Regional Structure, ...7.0029

Development

KINEMATICS OF SEDIMENTS IN BREAKERS ...Coastal Engineering-other, Hydrodynamics, Sedimentation, Suspension, Waves, ...7.0237

SUBMARINE CANYONS ...California, Erosional Features, Geomorphology-topography, Photography, Submarine Canyons, ...7.0295

GEOLOGIC HISTORY OF BERMUDA AND ITS RELATIONSHIP TO THE WORLD PLEISTOCENE ...Bermuda, Correlation, Local Stratigraphy, Quaternary Period, Sea Level Changes, ...7.0155

PHYSICAL GEOGRAPHY OF TROPICAL COASTAL LOWLANDS ...Geography-physical, Physical, Physical Features-general, Shore Features-general, Tropic, ...7.0298

COASTAL MORPHOLOGY ...Beach, Deltas, General Information Services, Shore Features-general, Shoreline - Coastline, Tropic, ...7.0297

REGIONAL COASTAL CHANGE ...Environmental Changes, Quaternary Period, Shoreline - Coastline, ...7.0301

NEARSHORE WAVE THEORY ...Model Studies, Sediment Transport-general, Shoreline - Coastline, Waves, ...2.0119

LITTORAL ENVIRONMENT OBSERVATION PROGRAM ...California, Erosion, Intertidal Areas, ...7.0289

A RECONNAISSANCE OF COASTAL EROSION IN NORTH CAROLINA ...Aerial Photography, Beach, Erosional Features, North Carolina, Photogrammetry, Reconnaissance, Shoreline - Coastline, Waves, ...7.0268

EVOLUTIONARY DEVELOPMENT OF CUSPATE FORELANDS ...Beach, Continental Shelf, Depositional Features-other, Deposits-other, North Carolina, Shoreline - Coastline, ...7.0296

GREAT LAKES RESEARCH - COASTAL AREA SEDIMENTATION ...Beach, Energy, General Transport Effects, Great Lakes-general, Model Studies, Sedimentation, ...7.0124

CORRELATION OF BEACH PROPERTIES AND INCIDENT WAVES ...Beach, Engineering Structures-general, General Transport Effects, Sea Level Variations, Shoreline Structures, Waves, ...8.0204

MARINE-FLUVIAL INTERFACE, COASTAL OREGON ...Heavy Minerals, Oregon, Placer, Processes, Shoreline - Coastline, Terrace-bench, ...7.0018

Erosional Features

SUBMARINE CANYONS ...California, Development, Geomorphology-topography, Photography, Submarine Canyons, ...7.0295

UNDERWATER GEOLOGY IN THE OSWEGO AREA OF LAKE ONTARIO ...Erosional Features-general, Geology-general, Lake Ontario, Photography, Sedimentary Structures-other, ...7.0044

STUDY OF BEACH NOURISHMENT ALONG THE SOUTHERN CALIFORNIA COAST ...Beach, California, Sediment Transport-general, Shoreline Structures, Supply Rate, ...7.0292

A RECONNAISSANCE OF COASTAL EROSION IN NORTH CAROLINA ...Aerial Photography, Beach, Development, North Carolina, Photogrammetry, Reconnaissance, Shoreline - Coastline, Waves, ...7.0268

Shore Features-general

CARIBBEAN GEOGRAPHY ...Beach, Caribbean Sea, Central America, Shoreline - Coastline, South America, ...7.0288

PHYSICAL GEOGRAPHY OF TROPICAL COASTAL LOWLANDS ...Development, Geography-physical, Physical, Physical Features-general, Tropic, ...7.0298

COASTAL MORPHOLOGY ...Beach, Deltas, Development, General Information Services, Shoreline - Coastline, Tropic, ...7.0297

STRATIGRAPHIC RELATIONS BETWEEN A COQUINA FACIES OF THE YORKTOWN FORMATION AND OVERLYING SEDIMENTS AT CHUCKATUCK, VIRGINIA ...Fossil Limestone, Sea Level Changes, Tertiary Period, Unconformities, Virginia, ...7.0254

Silica

MORPHOGENESIS OF THE DIATOM SHELL ...Algae-Diatoms, Cellular Membranes (non-spec.), Plant Developmental Biology, Structural Functions, ...5.0734

MORPHOGENESIS OF THE DIATOM SHELL ...Algae-Diatoms, Cellular Membranes (non-spec.), Intracellular Localization, Organelle & Membrane Formation, Plant Developmental Biology, ...5.0712

Silicon

THE CHARACTERISTICS, MECHANISMS AND BIOGEOCHEMICAL CONSEQUENCES OF PHYTOPLANKTON FLOTATION ...Organics, Phytoplankton, Plant Lipids, Size, Vertical Distribution, ...5.0826

STUDY OF DEEP PACIFIC CIRCULATION USING SILICON-32 ...Carbon, Circulation-general, General Sea Water Chemistry, Pacific Ocean-general, Tracers, ...2.0006

BIOCHEMICAL STUDIES ON SILICEOUS SKELETAL FORMATION ...Algae- Diatoms, Cell Wall, Golgi Apparatus, Histochemistry - Cytochem, Plant Developmental Biology, ...5.0750

Size Frequency Distribution

SEA WATER OPTICS STUDIES ...Estuaries, Optical, Suspension, ...1.0166

Snake River

JUVENILE MIGRATION RATES ...Columbia River, Mark, Tag Or Capture -other, Migration, Salmon & Trout - Non-specific, Water Environment -other, ...5.0223

PREDICTION OF ENVIRONMENT ...Biological-general, Columbia River, Environmental Ecology, Low Temp. -but Above 32f, Physical-general, Reservoirs and Impoundments, Salmon & Trout - Non-specific, Temperature, Thermal Pollution, ...5.0225

PROTECTION OF FINGERLING SALMON IN TURBINES ...Construction Land Use Effects, Engineering Structures-general, Migration, Mortality Rates, Salmon & Trout - Non-specific, ...8.0014

Snow Studies

Composition

MEASUREMENT OF COMMON LEAD IN THE EARTHS HYDROSPHERE ...Atomic Absorption, Greenland, Isotope Dilution, Lead, Other Sources, ...3.0069

Snow-general

ENVIRONMENTAL APPLICATIONS OF PASSIVE MICROWAVE SENSORS ...Beaches, Ice-general, Microwave Radiation, Sea Ice, Sedimentology-general, Soil Engineering Investigation, ...4.0136

Social Aspects

USE OF THE COASTAL ZONE FOR THE U. S. COASTLINE OF LAKE ERIE AND LAKE SUPERIOR ...Lake Erie, Lake Superior, Lakeshores-inlets, Land Use, Welfare Economics, ...9.0004

EFFECTS OF WATER POLLUTION IN SAN FRANCISCO BAY ...Bays, Economic Impact, Pollution - Effects of , Recreation Sites, San Francisco Bay, Water Utilization -domestic, Welfare Economics, ...6.0140

PRELIMINARY STUDIES OF INTERNATIONAL REGIMES FOR MARINE RESOURCES ...Economics, Legal Studies-general, Oceanography-general, ...10.0001

SOCIO-ECONOMIC STUDY OF NARRAGANSETT BAY, RHODE ISLAND ...Bays, Benefit-cost Analysis, Estuaries, Land Use, Rhode Island, Water Quality Control-general, ...9.0019

Social Sciences

Anthropology -other

MICRONESIAN NAVIGATION AND SAILING ...Caroline Islands, General Ethnology, Micronesia, Navigation, Navigation Communication, ...4.0094

Archeology

CHANGES IN SEA LEVEL IN NORTHERN TUNESIA ...Sea Level Variations, Sedimentation, Shoreline - Coastline, Tunisia, ...7.0208

General Ethnology

MICRONESIAN NAVIGATION AND SAILING ...Anthropology -other, Caroline Islands, Micronesia, Navigation, Navigation Communication, ...4.0094

Government

Intergovernmental Relations

EARTHQUAKE HAZARD - A PUBLIC POLICY PROBLEM IN THE SAN FRANCISCO BAY AREA ...California, Earthquakes, Faults, Forecasting-prediction, Policy Making, San Francisco Bay, ...9.0002

Policy Making

SYMPOSIUM ON THE MINERAL RESOURCES OF THE WORLD OCEAN ...Engineering Studies-general, Meetings, Ocean Mining, Rhode Island, ...7.0027

EARTHQUAKE HAZARD - A PUBLIC POLICY PROBLEM IN THE SAN FRANCISCO BAY AREA ...California, Earthquakes, Faults, Forecasting-prediction, Intergovernmental Relations, San Francisco Bay, ...9.0002

Labor

Manpower

SCIENCE AND ENGINEERING GOALS FOR THE INTERNATIONAL DECADE OF OCEAN EXPLORATION ...Economics, Oceanography-general, Planning, Project Review, Science & Technology, ...4.0118

ECONOMIC IMPACT OF MARINE-ORIENTED ACTIVITIES IN THE SOUTHERN NEW ENGLAND MARINE REGION ...Economics, Northeast, Regional Economic Impact, ...4.0187

Management and Administration

INSTITUTIONAL ARRANGEMENTS FOR THE MARINE SCIENCES ...International Affairs, Management, Oceanography-general, Savings and Investment, ...10.0005

Political Processes & Systems

International Affairs

INSTITUTIONAL ARRANGEMENTS FOR THE MARINE SCIENCES ...Management, Management and Administration, Oceanography-general, Savings and Investment, ...10.0005

Rural Sociology

Diffusion of Information

TECHNICAL ASSISTANCE TO INDUSTRY ...Alaska, Commercial Fishing, Fishing Gear, General Information Services, ...5.0031

Science & Technology

SCIENCE AND ENGINEERING GOALS FOR THE INTERNATIONAL DECADE OF OCEAN EXPLORATION ...Economics, Oceanography-general, Planning, Project Review, ...4.0118

PACIFIC SALMON FISHERIES - ECONOMICS OF MANAGEMENT ...Appraisals-general, Continental Shelf, International, Legal Review, Legal Studies-general, Ocean Mining, ...10.0006

Sodium

INTESTINAL ADSORPTION AND TRANSPORT OF NUTRIENTS IN ECHINODERANS ...Active Transport, Cellular Or Intracellular, Echinodermata -other, Intestine, Metabolism, ...5.0619

NEUROENDOCRINE REGULATION ...Brain, Crustacea -non-specific, Endocrine System, Osmoregulation, Water, ...5.0426

Soil Dynamics

CIVIL ENGINEERING STRUCTURES IN THE OCEANS ...Coastal Engineering-other, Engineering Studies-other, Foundations-general, Model Studies, Waves, ...8.0340

Soil Engineering Investigation

ENVIRONMENTAL APPLICATIONS OF PASSIVE MICROWAVE SENSORS ...Beaches , Ice-general, Microwave Radiation, Sea Ice, Sedimentology-general, Snow-general, ...4.0136

Soil Loads

LABORATORY MODEL STUDIES ON PRESSURE DISTRIBUTION IN DETRITUS DURING PENETRATION ...Laboratory Analysis, Mechanical Properties, Model Studies, Placer, Pressure, ...8.0253

Soil Properties - Other

OCEAN-SEDIMENTS AND CRUSTAL STRUCTURES IN THE BHAMIAN-CARIBBEAN AREA ...Caribbean Sea, Continental Slope, Crust, Ocean Basins, Textures-structures, ...7.0109

Soil Sampling

DEVELOPMENT OF DIAMOND DRILLING TECHNIQUES, FOR PHOSPHORITE DEPOSITS, USING STANDARD TOOLS PLUS BUOYANCY TANKS ...Bottom Sampling Device, Disturbed/undisturbed, Drilling and Coring, Phosphate, Technique Development, ...8.0248

DEVELOPMENT OF MARINE CHURN DRILL FOR SAMPLING UNCONSOLIDATED DEPOSITS ...Bottom Sampling Device, Drilling and Coring, Technique Development, Unconsolidated Deposits, ...8.0250

LABORATORY MODEL STUDIES OF COMPARTIVE METHODS OF PENETRATION OF DETRITUS ...Disturbed/undisturbed, Mechanical Properties, Ocean Mining, Rock Fragmentation Methods, Sand, ...8.0257

LABORATORY MODEL STUDIES OF PENETRATION INTO A SIMULATED COHESIONLESS DETRITUS ...Coring and Dredging, Gravel, Mechanical Properties, Model Studies, Technique Development, ...8.0245

LABORATORY MODEL STUDIES ON DISTURBANCE OF DETRITUS BY PENETRATION ...Disturbed/undisturbed, Model Studies, ...8.0252

Soil Testing

Soil Testing-general

BOTTOM SOIL PROPERTIES AND FOUNDATIONS ...Bearing Capacity, Consolidation, Foundations-general, Mechanical Properties, Shear Strength, ...8.0332

Soil Types

Disturbed/undisturbed

DEVELOPMENT OF DIAMOND DRILLING TECHNIQUES, FOR PHOSPHORITE DEPOSITS, USING STANDARD TOOLS PLUS BUOYANCY TANKS ...Bottom Sampling Device, Drilling and Coring, Phosphate, Soil Sampling, Technique Development, ...8.0248

LABORATORY MODEL STUDIES OF COMPARTIVE METHODS OF PENETRATION OF DETRITUS ...Mechanical Properties, Ocean Mining, Rock Fragmentation Methods, Sand, Soil Sampling, ...8.0257

LABORATORY MODEL STUDIES ON DISTURBANCE OF DETRITUS BY PENETRATION ...Model Studies, ...8.0252

Gravel

LABORATORY MODEL STUDIES OF PENETRATION INTO A SIMULATED COHESIONLESS DETRITUS ...Coring and Dredging, Mechanical Properties, Model Studies, Soil Sampling, Technique Development, ...8.0245

Sand

LABORATORY MODEL STUDIES OF COMPARTIVE METHODS OF PENETRATION OF DETRITUS ...Disturbed/undisturbed, Mechanical Properties, Ocean Mining, Rock Fragmentation Methods, Soil Sampling, ...8.0257

Solid Waste

MODEL ADVANCED WASTE-TREATMENT PLANT ...Activated Carbon, Lime Treatment, Material Recovery Wastes, Pilot Plant, Process Design, ...8.0326

COMPARATIVE TOXICITIES OF METALS TO ESTUARINE FISHES ...Bioassays, Estuaries, Industrial Wastes, Killifishs - Cyprinodon, Toxins -other, ...6.0184

SYSTEMS ANALYSIS FOR SHIPBORNE MUNICIPAL INCINERATION ...Distribution, Incinerators, Ocean, Pollution Sources-other, Smoke, ...8.0327

Solomon Islands

MARINE GEOPHYSICAL STUDIES IN THE PACIFIC OCEAN ...Crust, Gravity Studies, Magnetic Studies, Ocean Basins, Seismic Studies, ...7.0113

Sonar

HONEYWELL ACOUSTIC RESEARCH PROGRAM ...Acoustical, Data Acquisition, Data Analysis - General, Interfaces, Model Studies, Reverberation, ...1.0071

NAVIGATION RECEIVER ...Navigation, Navigation Systems-other, Radio, Transducers, Transponders, ...4.0112

DIGITAL OUTPUT SURVEY DEPTH SOUNDING ...Bathymetry, Coding, Digital Computer Applications, Readout Systems, Sound Gear, ...8.0123

ACOUSTIC IMAGE INVESTIGATION ...Acoustical, Reflection, Technique Development, ...1.0018

EXPERIMENTAL VERFICATION OF WIDE SWATH OCEAN BOTTOM CONTOURING WITH SPLIT BEAM RECEIVERS ...Bathymetry, Caribbean Sea, Receivers, Technique Development, Topographic, ...7.0302

ERROR ANALYSIS OF SEVERAL BOTTOM REFERENCED NAVIGATION SYSTEMS FOR SMALL SUBMERSIBLES ...Error Analysis, Navigation, Operational Aspect, Submersibles, Subsurface Environments, Systems Analysis, ...4.0111

EXPERIMENTAL HIGH RESOLUTION SUB-BOTTOM PROFILING SYSTEM ...Amplifiers, Receivers, Sonar and Echo Sounding, Subbottom, Transducers, ...8.0109

HIGH-POWER HYDROACOUSTIC VIBRATOR DEVELOPMENT ...Generation, Liquids, Seismic Studies, ...8.0165

DEPTH CONTROLLED STREAMER DEVELOPMENT ...Control-systems, Depth, Equipment, Hydrographic, ...8.0139

AN IMPROVED MARINE VIBROSEOS INSTALLATION ...Data Acquisition, Hydrographic, Special Mission Ships, ...8.0166

ADVANCE SONAR SYSTEMS ...Data Display, Instrumental Services, Sonar and Echo Sounding, Testing Facilities, Transducers, ...8.0096

CONVECTIVE STUDIES ...Convection, Pacific Ocean-north, Thermal, ...2.0011

DEVELOPMENT OF A PHOTOGRAPHIC SUIT FOR STEREOPHOTOGRAMMETRIC MAPPING BY SUMBERSIBLE ...Mapping, Navigation, Photography, Submersibles, Turkey, ...4.0060

BEHAVIOR AND SONIC ACTIVITY OF FISHES ...Behavioral Ecology, Environmental Physiology, Fish -other, Sound Production, ...1.0047

RESEARCH IN REGIONAL TOPOGRAPHIC ANALYSIS ...Acoustical, Geomorphology-topography, Seismic Studies, Subbottom, ...1.0063

OCEAN ENGINEERING STUDIES ...Applied Electronics, Data Acquisition, Data Processing Services, Engineering Studies-general, Instrumental Services, Laboratory Analysis, ...8.0052

SOUND TRANSMISSION IN THE SEA ...Acoustical, Signal Analysis-other, Transmission, ...1.0020

DEVELOPMENT OF UNDER-ICE HORIZONTAL SONAR SCANNING EQUIPMENT AND TECHNIQUES FOR LOCATING FISH SCHOOLS ...Behavioral Ecology, Commercial Fishing, Fish -non-specific, Lakes, Nets, ...8.0138

COOK INLET ESCAPEMENT ENUMERATION STUDY ...Alaska, Censusing, Migration, Organism Sampling Devices, Salmon -coho,chinook,sockeye.., Sonar and Echo Sounding, ...8.0112

DEVELOPMENT OF ANALYSIS TECHNIQUES AND EQUIPMENT FOR CLASSIFICATION OF TRANSIENT HYDROACOUSTIC SIGNALS ...Acoustical, Real Time Systems, Technique Development, ...1.0070

OCEANOGRAPHIC RESEARCH ...Acoustical, Buoys, Currents-ocean, Optical, Pressure, Seismic Studies, ...1.0151

SEAMOUNT INVESTIGATION ...Anomalies, Data Analysis - General, Geothermal, Magnetic Studies, Ocean Mining, Seamounts-guyots, ...7.0107

SWIMMER HIGH DEFINITION SONAR ...Diving and Scuba, Diving-system, Engineering Studies-other, Maintenance-system, Underwater-construction, ...8.0019

SONAR ACCURACY ...Acoustic, Acoustical, Fire Control, Instrumental Services, Platforms, Transmission, ...1.0051

BOTTOM-REFLECTED SONAR STUDIES ...Acoustical, Benthonic-bottom, Scattering, Surface Environments, Transmission, ...1.0025

SONIC UNDERWATER NAVIGATION FOR SHIPS ...Equipment, Instrumentation-other, Navigation, Ranging, Sound Gear, ...4.0100

WAVE RECORDING AND ANALYSIS ...Data Reduction and Analysis, Lasers-masers, Pressure, Radar, Statistics-general, Water Motion Recorders, Waves, ...2.0101

EVALUATION OF CONTEMPORARY ACOUSTIC, MAGNETIC AND GRAVIMETRIC METHODS FOR DETERMINING SIZE AND SHAPE OF DEPOSITS ...Geophysical Equipment, Gravity Studies, Instrumental Services, Magnetic Studies, Survey Studies, ...7.0007

TESTING AND EVALUATION OF HIGH-RESOLUTION ACOUSTIC SUBBOTTOM PROFILER THROUGH MODIFICATION OF OFF-THE-SHELF COMPONENTS ...Distribution, Electric Circuits and Networks, Evaluation Other, Field Testing, ...8.0115

UPGRADING CONVENTIONAL FISHING TECHNIQUES ...Commercial Fishing, Fishing Gear, Nets, Pacific Ocean-north, Telemetry, ...8.0150

ECHO RANGING SIGNALS ...Captive Rearing, Echolocation, Mark, Tag Or Capture -other, Seals, Sound Production, ...5.0546

South America

A SYSTEMATIC STUDY OF ENTOCYTHERID OSTRACODS ...Animal Taxonomy, Madagascar-malagasy Republic, New Zealand, Pubilications -other, Shrimps - Seed Or Mussel, ...5.0492

CARIBBEAN GEOGRAPHY ...Beach, Caribbean Sea, Central America, Shore Features-general, Shoreline - Coastline, ...7.0288

South Carolina

CHARTING OF SUBTIDAL OYSTER BEDS AND EXPERIMENTAL TRANSPLANTING OF SEED OYSTERS FROM POLLUTED SEED OYSTER BEDS ...Captive Rearing, Commercial Fishing, Estuaries, Oysters, Stocking of Fish & Shellfish, ...8.0011

WATERFOWL FOOD STUDIES ...Food Supply, Management, Plant Prod. (non-specific), Waterfowl -non-specific, ...5.0653

RADIONUCLIDES IN THE SAVANNAH RIVER ESTUARY AND ADJACENT COASTAL WATERS ...Pollutants - Path of , ...6.0185

Southeast Asia

VENOMOUS FISHES AND SEA SNAKES OF SOUTHEAST ASIA ...Behavior, Fish -non-specific, Snakes, Venom, Vertebrate Anatomy, ...6.0101

Space Crafts

VHF SATELLITE COMMUNICATIONS ...Navigation, Range and Tracking-other, Very High Frequency, ...4.0105

Communication & Navigation

VLF/OMEGA NAVIGATION ...Control-systems, Navigation, Navigation Communication, Satellites, ...4.0106

SATELLITE TIME DISSEMINATION ...Airborne Probing, Doppler, Navigation, Signal Generators, Standards, Specifications, Time Measurements, ...4.0091

EVALUATION OF CONTEMPORARY PRECISION NAVIGATION SYSTEMS ...Bathymetry, Navigation, Navigation Communication, Satellites, Technique Development, ...4.0087

Manned Satelite

NITROGEN-OXYGEN DECOMPRESSION TABLES FOR ALTITUDE FLIGHT ...Decompression Sickness, Diving, Safety, Space Medicine, Tables, Compilations, Catalogs, ...6.0099

Missile & Rockets

DEVELOPMENT OF AN ADVANCED MISSILE IMPACT LOCATING SYSTEM FOR THE EASTERN TEST RANGE ...Acoustical, Area, Atlantic Ocean-north, Navigation, Sound Gear, ...8.0048

Unmanned Satelite

SPACECRAFT OCEANOGRAPHY ...Instrumentation, Instrumentation-general, Management, Photography, Satellites, ...4.0157

Space Medicine

NITROGEN-OXYGEN DECOMPRESSION TABLES FOR ALTITUDE FLIGHT ...Decompression Sickness, Diving, Manned Satelite, Safety, Tables, Compilations, Catalogs, ...6.0099

Exobiology

GEOCHEMISTRY OF NUCLEIC ACIDS ...Biochemical, Biogeochemical Process, Chemistry, Nucleic Acids -non-specific, Organic, ...7.0054

BIOGEOCHEMISTRY OF TERRESTRIAL & EXTRATERRESTRIAL ORGANIC MATTER ...Biochemical, Biogenous, Biogeochemical Process, Diagenesis, Organic, Sulfur Bacteria, ...7.0074

STUDIES OF PROTEINS UNDER EXTREME ENVIRONMENTS ...Cellular Membranes (non-spec.), Cytochromes, Halobacteria, Respiration, Salt, ...5.0941

Spectroscopy

BIOCHEMISTRY OF MARINE ORGANISMS ...Adsorption & Interface, Bioluminescence, Fouling, Phytoplankton, Plant Succession, ...5.0766

Atomic Absorption

SPECTRAL SIGNATURES OF FISH SCHOOL IDENTIFICATION ...Fish -non-specific, Oil, Oils -fats, Spectral Reflectance, ...4.0151

ELEMENT CHEMISTRY ...Element Ratios, Industrial Wastes, Oceanic Fronts, Water Chemistry-other, ...1.0113

MEASUREMENT OF COMMON LEAD IN THE EARTHS HYDROSPHERE ...Composition, Greenland, Isotope Dilution, Lead, Other Sources, ...3.0069

Fluorometry

DETERMINATION OF CHLOROPHYLL DERIVATIVES ...Catabolism and Degradation, Cell Injury and Autolysis, Marine Plants, Phytoplankton, ...5.0770

UTILIZATION OF RADIOACTIVE TRACERS IN BEACH STUDIES ...Isotope Tracer-other, Tracers, ...7.0218

Infrared Spectroscopy

OIL MONITOR INSTRUMENTATION ...Chemical Analysis (water), Oil, ...8.0093

Mass Spectroscopy

RELATIONSHIP OF PHOTOSYNTHESIS TO RESPIRATION OF OCEANIC MICROALGAE ...Light, Marine Plants, Oxygen, Photosynthesis, Respiration, ...5.0774

MASS SPECTROMETRIC AND MANOMETRIC STUDIES OF THE OCEANS AND THE ATMOSPHERE ...Chemical Analysis (water), Gases, Ocean History, Particle-gas Transfer, Solubility, ...1.0101

RARE GAS STUDY OF INTERPLANETARY MATERIAL IN PELAGIC SEDIMENTS ...Chemistry, Cosmogenous, Element Ratios, Equipment Purchase Operation, Mineralogy, X-ray, ...7.0081

SHIPBOARD METHODS OF CHEMICAL ANALYSIS ...Caribbean Sea, Gases, Solubility, Technique Development, Water Analysis-general, ...1.0091

Nephelometry

BIOLOGICAL OCEANOGRAPHY & DETERIORATION - SHALLOW WATER MARINE SEDIMENTS & WATER COLUMN BACTERIA ...Biology, Continental Shelf, Instrumentation-general, Marine Bacteria, Vertical Distribution, ...5.0807

Ultrasonic Spectroscopy

EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS ...Conductivity, Electrolytes, Pressure, Solution, Sulfate, Sulfite, ...1.0079

X-ray

Other

SEDIMENTARY STRUCTURE ...General Deposition, Sediment Transport-general, Tectonics-general, Textures-structures, ...7.0280

Spoil Banks

GREAT LAKES RESEARCH - SPOIL DISPOSAL EFFECTS ...Dispersion -water, Great Lakes-general, Pollution - Effects of , Sediments, Suspension, Water Properties-general, ...6.0157

SAN PABLO BAY STUDY ...Bays, Benthic Fauna, Bottom Sampling Device, Excavation, Pollution - Effects of , ...6.0136

Stability Analysis

SEA FLOOR STUDIES - DEPOSITIONAL AND EROSION PROCESSES ...Bearing Capacity, Distribution, Erosion, Lithification-general, Sedimentation, ...7.0200

Stabilization

SEA BED INSTALLATION ...Benthonic-bottom, Deep, Diving and Scuba, Submersibles, Underwater-construction, ...8.0331

ELECTROKINETIC SOIL STUDY ...Buried Structures, Electro-osmosis, Electroosmosis, Electrophoresis, Laboratory Analysis, Marine Soils, ...8.0342

Standards, Specifications

CALCAREOUS NANNOFOSSILS FROM PALEOCENE EOCENE DEPOSITS ...Biogenous, Fossil Limestone, Fossil Zones, Microfossils, Tertiary Period, ...7.0176

PHOTOGRAPHIC STANDARDS ...Photography, Photography-chemistry, ...8.0077

HUMIDITY STANDARDS AND MEASUREMENTS ...Evaporation, Humidity, Humidity Instruments, Pressure-density, Streams, ...8.0081

DUPLICATE LIMIT STANDARDS FOR SIGNAL COLORS ...Air Traffic Control-other, Colorimetry, Filter, Navigation Communication, Traffic Control, ...4.0096

PH STANDARD REFERENCE MATERIALS FOR USE IN SEA WATER ...pH , Salinity, Water Analysis, Water Chemistry-other, ...1.0087

APPLICATION OF ISCC-NBS CENTROID COLORS AND METHOD OF DESIGNATION COLORS ...Colorimetry, Dyes and Coloring, Paint - General, Photography-chemistry, Pigments, ...4.0097

BASIC ACOUSTICAL STANDARDS AND MICROPHONE CALIBRATION ...Acoustic, Acoustical, Audio Frequency, Calibration and Calibrators, Transducers, ...8.0076

STANDARDS FOR AUDIOMETRY ...Acoustic, Calibration and Calibrators, Sound Level Analyzers, Transducers, ...8.0127

MECHANICAL TESTS AND FORCE CALIBRATIONS ...Force, ...8.0073

HUMIDITY CALIBRATION ...Humidity, Humidity Instruments, ...8.0084

SATELLITE TIME DISSEMINATION ...Airborne Probing, Communication & Navigation, Doppler, Navigation, Signal Generators, Time Measurements, ...4.0091

WWVB-WWVL BROADCASTS ...Frequency Standards, Low Frequency, Navigation, Radio, Signal Generators, Time Measurements, Very Low Frequency, ...4.0090

VLF TIMING STUDIES ...Attenuation, Absorption, Electromagnetic Transmission, Navigation, Time Measurements, Very Low Frequency, ...4.0092

CONSULTATIVE AND ADVISORY SERVICES - BATTERY PROBLEMS ...Batteries, Consultants, Advisory Services, Instrumental Services, ...11.0021

WATER CURRENT METERS ...Water Motion Recorders, ...8.0079

REFLECTIVITY AND EMISSIVITY STANDARDS ...Atmosphere Radiation, Infrared Radiation, Interferometry, Radiation, Radiation-general, ...4.0142

NAVAL AIRCRAFT LIGHTING ...Aircraft, Colorimetry, Equipment-instruments, Lighting, ...8.0080

SYSTEM OPERATIONS AND ACOUSTIC PHYSICS ...Acoustical, Economic Theory, Instrumentation-general, Liquids, Systems Analysis, ...12.0020

METAL ANALYSIS/TEST INSPECTION ...Flaw Detection - Other, Hull, Materials Used Undersea, Penetrating Ray, Ultrasonic and Sonic, ...8.0218

Steroids

Holothurin

ACTIVE CHEMICAL PRINCIPLES DERIVED FROM ECHINODERMS ...Chemoreceptors, Marine Plants, Toxicology, ...6.0117

Sterols

STEROLS AND LIPIDS IN WATER POLLUTION ...Chemical Identification, Effluents-waste Water, Lipid Hydroperoxides, Pollutants - Path of , Sewage, ...6.0186

PHYTOCHEMISTRY OF NARCOTIC PRINCIPLES IN CAULERPA. ...Caulerpa, Caulerpin, Phaeophyta (non-specific & Ot), Rhodophyta (non-specific & Ot), ...6.0111

Storm Water

CONSTRUCTION OF A FACILITY TO DEMONSTRATE OFF-SHORE UNDERWATER TEMPORARY STORAGE OF STORM OVERFLOW FROM A COMBINATION SEWER ...Combined Sewer, Elastomers, Rubber, Lake Erie, Tank, Pressure Vessel, Water Storage, ...8.0328

Strait of Gibraltar

OCEAN DYNAMICS IN THE STRAITS OF GIBRALTAR AND ADJACENT AREAS ...Acoustical, Anti-submarine-warfare, Computer Applications, Hydrodynamics, Model Studies, Submerged Ships, ...1.0141

Stratigraphic Studies

Correlation

RADIATION, DOSIMETRY, CORRELATION AND DATING OF CALCAREOUS DEEP-SEA CORES ...Carbonates-general, Core Analysis, Radioactive Dating, Sedimentation, Thermoluminescence, ...7.0251

LITHOLOGICAL AND MICROPALEONTOLOGICAL INVESTIGATION OF OCEAN SEDIMENT CORES ...Core Analysis, Paleoclimatology, Quaternary Period, Sedimentary History, Tertiary Period, ...7.0257

STRATIGRAPHIC STUDY OF RADIOLARIA IN DEEP SEA QUATERNARY SEDIMENTS ...Collections, Core Analysis, Geographical Relations, Order Radiolaria, Quaternary Period, ...7.0178

STRATIGRAPHY OF UNCONSOLIDATED SEDIMENTS ON THE CONTINENTAL SHELVES OF THE CHUKCHI AND NORTHERN BERING SEAS ...Bering Sea, Chuckchi Sea, Continental Shelf, Core Analysis, Oceanic Fronts, Sedimentary History, ...7.0286

GEOLOGIC HISTORY OF BERMUDA AND ITS RELATIONSHIP TO THE WORLD PLEISTOCENE ...Bermuda, Development, Local Stratigraphy, Quaternary Period, Sea Level Changes, ...7.0155

GEOCHEMISTRY OF MID-ATLANTIC RIDGE SEDIMENTS ...Atlantic Ocean-general, Chemistry, Core Analysis, Geochronology-general, Ridges, ...7.0071

PALEONTOLOGY OF LATE CENOZIC ANTARCTIC RADIOLARIA AND DIATOMS ...Antarctic Ocean, Antarctica, Class Algae, Ocean Basins, Order Radiolaria, Paleomagnetism, Paleontology, Rate of Deposition, ...7.0185

PLEISTOCENE OCEANOGRAPHY AS RECORDED IN DEEP SEA SEDIMENT CORES ...Core Analysis, Geographical Relations, Paleoclimatology, Paleotemperature, Quaternary Period, ...7.0165

STRATIGRAPHY AND PALEOECOLOGY OF FOSSIL SILICOFLAGELLATES FROM ANTARTIC DEEP-SEA CORES ...Antarctic Ocean, Core Analysis, Field Reversals, Fossil Zones, Paleontology, Paleotemperature, Phylum Protozoa, ...7.0169

TAXONOMY AND STRATIGRAPHY OF CALCAREOUS NANNOPLANKTON IN MARINE SEDIMENT SEQUENCES ...Biogenous, Classification - Taxonomy, Fossil Limestone, Microfossils, Order Foraminifera, Paleontology, ...7.0168

CORRELATION OF SUBMARINE VOLCANIC ASH BY CATHODO-LUMINESCENCE ...Extrusives, Geochronology-general, Luminescence, Qualitative, Size, ...7.0255

BIOSTRATIGRAPHY OF MID-ATLANTIC RIDGE SEDIMENTS ...Biofacies, Biogenous, Ocean History, Order Foraminifera, Ridges, ...7.0209

ACOUSTIC PROPERTIES OF SEDIMENTS ...Acoustical, Physical Properties, Seismic Studies, Subbottom, Texture, ...7.0108

Facies

RECENT MARINE AND NONMARINE SEDIMENTS AND MICROFAUNA OF DELAWARE COASTAL AREAS ...Bays, Delaware, Paleoenvironments, Quaternary Period, Sedimentary Structure-general, Shoreline - Coastline, ...7.0207

Intercontinental Stratigraphy

STRATIGRAPHIC AND TAXONOMIC-PHYLOGENETIC STUDIES ON PLANKTONIC FORAMINIFERA ...Core Analysis, Cretaceous Period, Order Foraminifera, Structure-general, Tertiary Period, ...7.0182

Lithology

DEEP OCEAN AS RECIPIENT OF VOLATILES AND SOLUTES ...Hydrothermal Minerals, Igneous Activity - Volcanism, Pacific Ocean-east, Ridges, Sea Floor Spreading, Thermal Features, Water Analysis-general, ...7.0095

Local Stratigraphy

GEOLOGIC HISTORY OF BERMUDA AND ITS RELATIONSHIP TO THE WORLD PLEISTOCENE ...Bermuda, Correlation, Development, Quaternary Period, Sea Level Changes, ...7.0155

THE SEDIMENTARY AND DIAGENETIC RECORD OF ENVIRONMENTAL PARAMETERS IN RECENT BAHAMIAN

TIDAL FLATS ...British West Indies, Diagenesis, Environmental Effectsygeologic, Intertidal Areas, Paleoclimatology, ...**7.0163**

CORING OF THE VARVED SEDIMENTS IN SAANICH INLET ...Canada, Coring and Dredging, Geochronology-general, Pacific Ocean-east, Varves, ...**7.0282**

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SEDIMENT AND VOLCANIC STUDIES ...Distribution, Origin, Pacific Ocean-north, Sedimentary Petrology, Volcanic, ...**7.0189**

STRATIGRAPHY OF RECENT INTERTIDAL SEDIMENTMENTARY DEPOSITS OF THE SHEEPSHEAD MUDFLAT, NEW JERSEY ...Intertidal Areas, New Jersey, Quaternary Period, Sediments-other, ...**7.0274**

A SEDIMENTOLOGIC STUDY OF MOBILE BAY AND PERDIDO BAY ...Alabama, Bays, Distribution, Ocean History, Rate of Deposition, ...**7.0231**

Subsurface

SUBSURFACE GEOLOGY OF HOGSTY REEF, AN ATOLL IN THE SOUTHEASTERN BAHAMAS ...Atolls, British West Indies, Paleoenvironments, Physiographic History, Quaternary Period, Submergent, ...**7.0037**

LAKE SUPERIOR CORING III ...Core Analysis, Lake Superior, Sedimentology-general, Seismic Studies, Textures-structures, ...**7.0247**

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STRATIGRAPHIC RELATIONS BETWEEN A COQUINA FACIES OF THE YORKTOWN FORMATION AND OVERLYING SEDIMENTS AT CHUCKATUCK, VIRGINIA ...Fossil Limestone, Sea Level Changes, Shore Features-general, Tertiary Period, Virginia, ...**7.0254**

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THE INSTITUTE FOR THE DEVELOPMENT OF RIVERINE AND ESTUARINE SYSTEMS (IDRES) ...Delaware River, Estuaries, Waste Disposal-general, ...**12.0043**

(U) THE EFFECTS OF OCEANIC PROCESSES ON THE DEPOSITION OF RIVER SEDIMENTS ...Physical Properties, Rate of Deposition, Sediment Relationship, Sedimentation, ...**7.0197**

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INVESTIGATION OF ANADROMOUS DOLLY VARDEN POPULATIONS IN HOOD BAY DRAINAGES, SOUTHEASTERN ALASKA ...Alaska, Lake Trout, Brook Trout, Migration, Population Dynamics, ...**5.0013**

FISH POPULATIONS IN THE CHENA RIVER ...Alaska, Pikes, Pickeral, Muskellunge, Population Dynamics, Salmon & Trout - Non-specific, ...**5.0029**

TAG DETECTION ...Commercial Fishing, Number Or Density, Puget Sound, Salmon -coho,chinook,sockeye.., Tags, ...**8.0148**

MONITORING THE EFFECTS OF LAND USE ON SALMON PRODUCTION ...Alaska, Environmental Ecology, Land Use, Pulp, Paper , and Logging, Salmon & Trout - Non-specific, ...**5.0192**

BIOLOGY OF ANADROMOUS ALOSIDS ...Alewife,menhaden,shad,herring, Mortality Rates, Spawning & Nesting Sites, Tidal Streams, Virginia, ...**5.0150**

IDENTIFICATION OF RED SALMON STOCKS TAKEN IN THE CAPE KUMLIK-ANIAKCHAK BAY FISHERY (CHIGNIK AREA) ...Alaska, Commercial Fishing, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, Tags, ...**5.0021**

STOCKING AND SURVIVAL OF STRIPED BASS FINGERLINGS ...Alabama, Basses -sea,white, White Perch, Commercial Fishing, Maturity & Growth Stages, Stocking of Fish & Shellfish, ...**5.0001**

SOCKEYE SALMON MIGRATORY BEHAVIOR AND BIOLOGICAL STATISTICS COLLECTION, SOUTHEASTERN ALASKA ...Alaska, Behavioral Ecology, Censusing, Migration, Salmon -coho,chinook,sockeye.., ...**5.0027**

OFFSHORE SALMON ABUNDANCE INDEX ...Alaska, Commercial Fishing, Number Or Density, Salmon -coho,chinook,sockeye.., ...**5.0028**

STREAM IMPROVEMENT PLANNING ...Benefit-cost Analysis, Engineering Structures-general, Fish -non-specific, Management -other, Planning, ...**5.0220**

COPPER RIVER SOCKEYE SALMON INVESTIGATIONS ...Alaska, Commercial Fishing, Migration, Nets, Salmon - coho,chinook,sockeye.., ...**5.0026**

PRE-EMERGENT FRY PINK SALMON FORECAST (KODIAK, ALASKA) ...Alaska, Maturity & Growth Stages, Number Or Density, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, ...**5.0017**

EXPERIMENTAL AND THEORETICAL STUDY OF THE HYDRODYNAMICS OF DISPERSION IN RIVERS AND ESTUARIES ...Dispersion -water, Estuaries, Flow Characteristics -water, Model Studies, Water Motion, ...**2.0057**

EFFECTS OF RIVERS ON THE METABOLISM OF TEXAS BAYS ...Bays, Nutrients, Pollutants-general, Primary Productivity, Texas, Water Quality-general, ...**6.0187**

REPOPULATION OF DECIMATED SECTIONS OF WARMWATER STREAMS BY LONGEAR SUNFISH, LEPOMIS MEGALOTIS (RAFINESQUE) ...Aquatic Ecology, Population Dynamics, Stocking of Fish & Shellfish, Sunfish, Rock & Roanoke Bass.., Warm Water, ...**5.0097**

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ECOLOGY OF KRAFT PAPER MILL EFFLUENT IN SAPELO & ST. CATHERINES SOUNDS, GA ...Aquatic Ecology, Georgia, Pollution - Effects of , Pollution Effects, Pulp, Paper , and Logging, ...**5.0886**

EVALUATION OF ESCAPEMENT OF ADULT SALMON TO OREGON COASTAL STREAMS ...Environmental Ecology, Number Or Density, Oregon, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, ...**5.0215**

SURVEYS OF SPAWNING SALMON ...Biological Rhythms, Censusing, Number Or Density, Oregon, Salmon & Trout - Non-specific, ...**5.0142**

INVENTORY SURVEYS OF OREGON COASTAL STREAMS ...Management -other, Oregon, Rainbow Trout, Steelhead Trout, Salmon & Trout - Non-specific, Spawning & Nesting Sites, ...**5.0217**

POPULATION ESTIMATES OF JUVENILE COHO SALMON IN SIX COASTAL STREAMS ...Environmental Ecology, Maturity & Growth Stages, Population Dynamics, Salmon - coho,chinook,sockeye.., ...**5.0144**

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DISTRIBUTION AND ABUNDANCE OF OYSTER DRILLS (UROSALPINX CINEREA) IN THE JAMES RIVER, VIRGINIA ...Aquatic Ecology, Gastropods -slugs,conch,snails, Number Or Density, Vertical Distribution, Virginia, ...**5.0508**

INFAUNA OF LOWER CHESAPEAKE BAY ...Aquatic Ecology, Chesapeake Bay, Population Dynamics, Shrimp - Amphipods, Virginia, ...**5.0661**

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TIDAL FLOWS IN RIVERS AND HARBORS ...Committee-support, Harbors, Hydraulics-general, Tides, ...**2.0087**

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DISPERSION PROCESSES IN ESTUARIES AND RIVERS ...Dispersion -water, Dyes, Estuaries, Synthetic Hydrology, ...**2.0050**

CULTURE OF SHELLFISH IN ARTIFICIAL AND NATURAL SALT PONDS ...Captive Rearing, Growth Rate, Oysters, Ponds, Stocking of Fish & Shellfish, ...**5.0444**

POTENTIAL OYSTER SETTING CAPACITY - LOCAL AREAS ...Chesapeake Bay, Commercial Fishing, Mark, Tag Or Capture -other, Oysters, Spawning & Nesting Sites, ...**5.0445**

NAKNEK SYSTEM RED SALMON STUDIES ...Alaska, Growth Rate, Migration, Number Or Density, Salmon -coho,chinook,sockeye.., ...**5.0005**

ADULT SALMON BEHAVIOR STUDIES IN RIVERS AND AT DAMS (SONIC TRACKING) ...Behavioral Ecology, Engineering Structures-general, Salmon & Trout - Non-specific, Tags, Telemetry, ...**8.0111**

COLLECTION OF JUVENILE MIGRANTS FROM RIVERS AND STREAMS ...Electric Power Plants, Engineering Structures-general, Fish -non-specific, Management -other, Migration, ...**5.0513**

LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...Aquatic Ecology, Control of Nuisance Species, Lake Superior, Lampreys, Larvicides, ...**5.0628**

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PINK SALMON INVESTIGATIONS - FRESHWATER ECOLOGY ...Alaska, Aquatic Ecology, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, Water Properties-general, ...5.0185

FISH TRANSPORTATION ...Aquatic Ecology, Management - other, Migration, Salmon & Trout - Non-specific, Tags, ...8.0013

ISOLATION AND TAXONOMY OF YEASTS IN LAKES AND SEWAGE ...Bioindicators, Contamination, Pollution-water, Plant Taxonomy, Yeasts (non-specific), ...5.0787

OSMOREGULATION ...Aquatic Ecology, Osmoregulation, Rays, Skates, Mantas, Sawfish, Sharks, ...5.0280

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Scouring

LOCALIZED SCOUR AROUND PILING SUBJECTED TO FIRST-ORDER STOKIAN WAVES ...Erosion Control, Model Studies, Water Tunnels Tables, Wave Action, Waves in Liquids, ...8.0043

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TIMBALIER - TERREBONNE BAYS SYSTEM ...Benthic Fauna, Louisiana, Number Or Density, Plankton Sampling, Vertical Distribution, ...5.0092

BRETON SOUND - MOUTH OF MISSISSIPPI RIVER SYSTEM ...Benthic Fauna, Louisiana, Number Or Density, Plankton Sampling, Vertical Distribution, ...5.0093

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ISOTOPIC AND TRACE ELEMENT STUDIES IN OCEANIC VOLCANIC ROCKS ...Igneous Rocks, Lead, Magma, Magmas, Petrology, Rare Earth Studies, Trace Element Analysis, Volcanic, ...7.0075

STRONTIUM ISOTOPE COMPOSITION AND TRACE ELEMENT CONCENTRATIONS IN LAKE HURON AND ITS PRINCIPAL TRIBUTARIES ...Chemical, Ions and Gases, Lake Huron, Rocks - Bedrock, Trace Element Analysis, ...1.0124

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RADIOACTIVE AEROSOL SCAVENGING BY OCEAN SPRAY ...Aerosols, Nuclear Explosions - Fallout, Radioactivity-general, Washout, Waves, ...6.0164

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Fault Complexes

STUDY OF RELATIONSHIP BETWEEN EARTHQUAKES AND TECTONIC MOVEMENTS IN ALASKAN FAULT ZONE ...Alaska, Crustal Fracturing, Deformation, Earthquakes, Forecasting-prediction, ...7.0139

REFLECTION PROFILING OF THE SEA FLOOR ...Atolls, Continental Shelves, Geomorphology-topography, Pacific Ocean-general, Seismic Reflection, ...7.0091

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EARTHQUAKE HAZARD - A PUBLIC POLICY PROBLEM IN THE SAN FRANCISCO BAY AREA ...California, Earthquakes, Forecasting-prediction, Intergovernmental Relations, Policy Making, San Francisco Bay, ...9.0002

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SEISMOLOGICAL RESEARCH RELATED TO WORLD-WIDE SEISMIC DATA ...Earthquakes, Propagation, Seismic Studies, Structure Location, Surface, ...7.0141

DETECTION OF DEEP-SEATED ANOMALIES IN ELECTRICAL CONDUCTIVITY UNDER THE GULF OF CALIFORNIA ...Anomalies, Conductivity, Continental Drift, Gulf of California, Heat Flows, ...7.0099

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INELASTIC SEISMIC EFFECTS ...Earthquakes, Model Studies, Propagation, Surface, Wave Propagation Media, ...7.0089

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GEOTHERMAL INVESTIGATIONS IN OCEAN REGIONS ...Atlantic Ocean-general, Geothermal, Heat Flow Measurements, Model Studies, Technique Development, ...7.0121

GEOPHYSICS, GULF OF MEXICO ...Gulf of Mexico, Ocean Basins, Seismic Studies, Structural Studies, Trenches, ...7.0148

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MARINE SEISMOLOGY ...Distribution, Earth Interior, Seismic Reflection, Seismic Refraction, Textures-structures, ...7.0131

ARCTIC BASIN HEAT FLOW ...Arctic, Coring and Dredging, Geothermal Gradient, Heat Flows, Physical Properties, ...7.0105

PACIFIC GRAVITY ...Anomalies, Earth Interior, Geophysical Equipment, Gravity Studies, Pacific Ocean-north, ...7.0144

MARINE GEOLOGY AND GEOPHYSICS ...Continental Shelf, Geophysics-general, Ocean Basins, Sedimentation, Textures-structures, ...7.0048

MARINE GEOPHYSICS ...Field Characteristics-general, Gravity Studies, Gulf of Mexico, Physical Properties, Seismic Studies, ...7.0149

INDUCTION IN THE OCEAN ...Currents-ocean, Earth Interior, Fluctuations, Induction, Oceanic Fronts, ...1.0137

ANALYSES OF ROCKS COLLECTED IN THE INDIAN AND ATLANTIC OCEANS ...Atlantic Ocean-general, Indian Ocean-general, Ocean Basins, Petrology, Structural Studies, ...7.0073

ATLANTIC OCEAN CRUSTAL STUDIES ...Atlantic Ocean-general, Bathymetry, Coring and Dredging, Heat Flow Measurements, Seismic Reflection, ...7.0116

GEOPHYSICAL INVESTIGATIONS IN THE CORAL SEA ...Buoys, Coral Sea, Regional Structure, Seismic Refraction, Structural Studies, ...7.0130

GEOLOGICAL AND GEOPHYSICAL INVESTIGATION OF THE BAHAMA BANK ...Banks, Bathymetry, British West Indies, Magnetic Studies, Seismic Studies, ...7.0110

(U) OCEANIC CRUSTAL AND MANTLE STRUCTURE - ITS ORIGIN AND EFFECT ON EXTERNAL FILEDS ...Anti-submarine-warfare, Earth Interior, Earth Magnetism, Ocean Basins, Origin, ...7.0145

MARINE GEOPHYSICAL STUDIES IN THE PACIFIC OCEAN ...Gravity Studies, Magnetic Studies, Ocean Basins, Seismic Studies, Solomon Islands, ...7.0113

OCEAN-SEDIMENTS AND CRUSTAL STRUCTURES IN THE BHAMIAN-CARIBBEAN AREA ...Caribbean Sea, Continental Slope, Ocean Basins, Soil Properties - Other, Textures-structures, ...7.0109

SUBSURFACE RESISTIVITY ...Earth-telluric Current, Magnetic Surveys, Ocean Basins, Resistance, Texas, ...7.0147

ROCKS OF OCEANIC CRUST AND UPPER MANTLE EQUATORIAL ATLANTIC ...Atlantic Ocean-general, Earth Interior, Ocean Basins, Petrogenesis-general, Petrology, Stability Fields, ...7.0059

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Earth Interior

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INDUCTION IN THE OCEAN ...Crust, Currents-ocean, Fluctuations, Induction, Oceanic Fronts, ...1.0137

MOHOLE SITE STUDIES ...Coring and Dredging, Hawaii, Pacific Ocean-north, Seismic Studies, Structure Location, ...7.0097

GEOTHERMAL STUDIES IN DEEP-SEA DRILL HOLES ...Abyssal, Bathyal, Borehole Geophysics, Core Temperature, Geothermal, Heat Flow Measurements, Heat Flows, Sediments-general, Technique Development, ...7.0122

(U) OCEANIC CRUSTAL AND MANTLE STRUCTURE - ITS ORIGIN AND EFFECT ON EXTERNAL FILEDS ...Anti-submarine-warfare, Crust, Earth Magnetism, Ocean Basins, Origin, ...7.0145

UPPER MANTLE OF OCEAN REGIONS ...Extrusives, High Pressure Research, High Temperature Research, Lava, Petrology, Ridges, ...7.0053

GRAVITY AND EARTH TIDES ...Antarctica, Earth Tides, General Gravimeters, Propagation, Tides, ...2.0077

ROCKS OF OCEANIC CRUST AND UPPER MANTLE EQUATORIAL ATLANTIC ...Atlantic Ocean-general, Crust, Ocean Basins, Petrogenesis-general, Petrology, Stability Fields, ...7.0059

Geosynclines

SEDIMENT STRUCTURE ...Coral Sea, Distribution, Sediment Transport-general, Shelf Areas, Textures-structures, ...7.0204

Island-arcs

DEEP EARTHQUAKES AND ISLAND-ARC TECTONICS AND STRUCTURE ...American Samoa, Attenuation, Earthquake Location, Earthquakes, Seismic Studies, Velocity Variations, ...7.0140

Ocean Basins

STUDY OF EARTH NOISE ON LAND AND SEA BOTTOM ...Microseisms - Background, Propagation, Seismic Studies, Structural Studies, ...7.0094

MARINE GEOLOGY AND GEOPHYSICS ...Continental Shelf, Crust, Geophysics-general, Sedimentation, Textures-structures, ...7.0048

GEOPHYSICAL INVESTIGATIONS OF THE SOUTHWEST MARGIN OF JAPAN ...Distribution, Japan, Regional Structure, Ships and Cruises, Trenches, ...7.0045

ANALYSES OF ROCKS COLLECTED IN THE INDIAN AND ATLANTIC OCEANS ...Atlantic Ocean-general, Crust, Indian Ocean-general, Petrology, Structural Studies, ...7.0073

INDIAN OCEAN DATA REDUCTION ...Bathymetry, Data Analysis - General, Geophysics-general, Indian Ocean-general, Sedimentology-general, ...4.0034

(U) OCEANIC CRUSTAL AND MANTLE STRUCTURE - ITS ORIGIN AND EFFECT ON EXTERNAL FILEDS ...Anti-submarine-warfare, Crust, Earth Interior, Earth Magnetism, Origin, ...7.0145

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SEDIMENT STRUCTURE ...Coral Sea, Distribution, Geosynclines, Sediment Transport-general, Textures-structures, ...7.0204

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STRUCTURE OF CONTINENTAL RISE OFF EASTERN NORTH AMERICA ...Cenozoic Era-general, Continental Slopes, Eastern, Sedimentary History, Sedimentation, ...7.0117

DETECTION OF DEEP-SEATED ANOMALIES IN ELECTRICAL CONDUCTIVITY UNDER THE GULF OF CALIFORNIA ...Anomalies, Conductivity, Gulf of California, Heat Flows, Rift, ...7.0099

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Igneous Activity - Volcanism

AZORES VOLCANIC STUDY ...Atlantic Ocean-general, Azores, Element Ratios, Ridges, Volcanic, ...8.0195

DEEP OCEAN AS RECIPIENT OF VOLATILES AND SOLUTES ...Hydrothermal Minerals, Lithology, Pacific Ocean-east, Ridges, Sea Floor Spreading, Thermal Features, Water Analysis-general, ...7.0095

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WESTERN PACIFIC ISLANDS ...Hawaii, Lava, Mapping, Petrology, Sea Level Changes, ...7.0104

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MARINE GEOLOGY ...Acoustical, Bathymetry, Geomorphology-topography, Magnetic Studies, Mapping, ...7.0041

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MARINE SEDIMENTS ...Atlantic Ocean-south, Bathymetry, Magnetic Studies, Ridges, Textures-structures, ...7.0203

HEAT FLOW AND MAGNETICS IN THE PHILIPPINE SEA ...Arcs, Heat Flow Measurements, Magnetic Studies, Philippine Sea, Trenches, ...7.0137

SEDIMENTATION, MORPHOLOGY, AND STRUCTURE--MID-ATLANTIC RIDGE ...Atlantic Ocean-general, Distribution, Ocean History, Provenance Studies-other, Ridges, ...7.0047

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GEOPHYSICAL STUDIES FROM ELTANIN IN 1968 ...Antarctic Ocean, Gravity Surveys, Paleomagnetism, Seismic Reflection, Textures-structures, ...7.0133

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GEOMAGNETIC INVESTIGATIONS ...Anomalies, Gravity Studies, Magnetometers, Ridges, Structural Studies, ...7.0120

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GEOLOGIC SURVEY OF MARTABAN CANYON, NORTHEASTERN INDIAN OCEAN ...Andaman Sea, River Deltas, Sedimentary History, Submarine Canyons, Valleys, ...7.0039

A STUDY OF THE STRUCTURAL RELATIONS BETWEEN THE MID-PACIFIC OCEANIC RIDGES AND FRACTURE ZONES ...Anomalies, Ocean History, Polynesia, Ridges, Structural Studies, ...7.0111

MARINE GEOLOGY OF THE SAN FRANCISCO BAY ...Bays, Geology-general, Gold, Mechanical Properties, San Francisco Bay, Structural Studies, ...7.0035

Tectonics-general

TECTONIC AND GEOLOGICAL HISTORY OF THE SOUTHWEST PACIFIC REGION ...Gases, Geophysics-general, Island Arcs, Oceans - Sea Water, Pacific Ocean-south, Structural Studies, ...7.0031

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RESTORATION AND REHABILITATION OF EARTHQUAKE DAMAGED PINK AND CHUM SALMON STUDIES IN PRINCE WILLIAM SOUND ...Alaska, Earthquakes, Flow Characteristics -water, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, Stream Rehabilitation, ...5.0191

MARINE GEOLOGY STUDIES, GULF OF MEXICO-CARIBBEAN REGION ...Dimensions-distribution, Distribution, Geology-general, Gulf of Mexico, Ocean Mining, ...7.0103

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STRESSES DEVELOPED ON THE SURFACE OF CYLINDRICAL JOINTS SUBJECTED TO MULTIPLE LOADS ...Analysis Structural, Geometric Configuration, Moments, Stress Concentration, Stresses, ...8.0304

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SHIP STRUCTURE LABORATORY TESTING AND ANALYSES ...Bulkheads, Experiments and Tests, Hull, Models, ...8.0261

STRUCTURAL DESIGN CRITERIA ...Flaw Detection - Other, Hull, Process Control, Safety, Stress Concentration-toughness, ...8.0283

WAVE UPLIFT FORCES ON HORIZONTAL PLATFORMS ...Platforms, Wave Action, Waves, ...8.0266

A STUDY OF THE INTERFACE LOCATIONS BETWEEN DISSIMILAR MATERIALS AND OTHER ASPECTS OF A COMPOSITE MIDSHIP SECTION ...Bulkheads, Hull, Strength, ...8.0294

DESIGN AND CONSTRUCTION ...Coatings-general, Environmental Effects-geologic, Safety, Underwater-construction, Water, ...8.0333

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ERROR ANALYSIS OF SEVERAL BOTTOM REFERENCED NAVIGATION SYSTEMS FOR SMALL SUBMERSIBLES ...Error Analysis, Navigation, Operational Aspect, Sonar, Subsurface Environments, Systems Analysis, ...4.0111

DEVELOPMENT OF A SENSOR, INSTRUMENTATION AND COMMUNICATION SYSTEM FOR A DEEP OCEAN MANNED HABITAT (ATLANTIS) ...Continental Shelf, Navigation Communication, Ridges, Safety, Underwater-laboratory, ...8.0107

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DEEP SUBMERGENCE VEHICLES - DYNAMIC ANALYSES ...Data Acquisition, Experiments and Tests, Mathematical Analysis, Model Studies, Technique Development, Underwater-laboratory, ...8.0264

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PASSIVE BUOYANCY SYSTEMS ...Buoyant, Flotational, Engineering Studies-general, Foam, Porous, Materials Used Undersea, Other-design-and-construction, ...8.0263

RESEARCH SUBMARINE BEAVER MK IV ...Control-systems, Diving and Scuba, Scientific-service-support, Technique Development, Underwater-laboratory, ...8.0265

DEEP SUBMERGENCE SYSTEMS ...Buoyant, Flotational, Geomorphology-topography, Marine Propulsion, Navigation Communication, Physical Properties, Welding - Other, ...**8.0051**

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SATURATED DIVING FACILITIES FOR DIVER-SCIENTIST AND RELATED RESEARCH ...Controls, Data Acquisition, Marine Environments-general, Model Studies, Underwater-construction, Underwater-laboratory, ...**8.0311**

OCEAN DYNAMICS EXPERIMENTS ...Buoys, Moorings, Other-design-and-construction, Technique Development, Temperature, Water Motion Recorders, ...**2.0072**

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OCEANOGRAPHIC RESEARCH ...Acoustical, Forecasting-prediction, Temperature, ...**1.0161**

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DEEP SEA SUBMERSIBLES ...Control-systems, Hull, Life-support-system, Marine Propulsion, Moorings, ...**8.0292**

DEEP OCEAN RESEARCH AND DEEP OCEAN ENGINEERING ...Abyssal, Engineering Studies-general, Geophysics-general, Marine Biology, Structural Studies, Textures-structures, ...**4.0131**

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A DUAL MODE ROLE STABILIZATION SYSTEM ...Applications, Control-systems, Development of Models, Models, Ship Resistance Stability, ...**8.0302**

STRENGTH OF GLASS ...Glass, Strength, Cohesion, Stress Rupture, ...**8.0206**

HELIUM - HEAT TRANSFER ...Air, Diving and Scuba, Heat Transfer, Helium, Temperature Effects, ...**8.0201**

MECHANICAL PROPERTIES ...Environment General, Liquid, Mechanical Properties, Special Mission Ships, Test Methods, ...**8.0210**

BIOLOGICAL OCEANOGRAPHY ...Acoustical, Atlantic Ocean-north, Marine Biology, Sound Production, ...**1.0022**

BIOLOGICAL OCEANOGRAPHY AND DETERIORATION, DEEP OCEAN-HIGH PRESSURE BACTERIA ...Biological, Biology, Chemistry, Identification, Microorganisms (non-specific), ...**8.0236**

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DEEP OCEAN ACOUSTIC RESEARCH ...Abyssal, Acoustical, Pressure, Textures-structures, Transmission, Velocity, ...**1.0010**

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DEEP RECOVERY SYSTEM ...Navigation Communication, Operational Aspect, Other-design-and-construction, Recovery Vehicle, ...**8.0267**

PROPULSION FOR SWIMMER VEHICLES ...Closed-cycle, Diving and Scuba, Marine Propulsion, ...**8.0159**

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EXPLORE FISHERY AND RESEARCH APPLICATIONS OF SUBMARINES ...Naval Architecture-general, Other-design-and-construction, Submerged Ships, ...**8.0286**

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ERROR ANALYSIS OF SEVERAL BOTTOM REFERENCED NAVIGATION SYSTEMS FOR SMALL SUBMERSIBLES ...Error Analysis, Navigation, Operational Aspect, Sonar, Submersibles, Systems Analysis, ...**4.0111**

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LONG RANGE SOFAR FLOATS ...Acoustical, Currents-ocean, Physical Analysis, Water Motion, Water Motion Recorders, ...**2.0025**

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STUDY OF OCEANIC TURBULENCE ...Energy, Hydrodynamics, Mixing, Turbulence - Sea Water, Water Motion, ...**2.0055**

CURRENTS AND WATER MASSES IN THE SOUTHWEST ATLANTIC ...Circulation-general, Currents-ocean, Oceanic Fronts, ...**2.0041**

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SHALLOW WATER OCEANOGRAPHY ...Continental Shelf, Environmental Effects-geologic, Forecasting-prediction, Pressure, Waves, ...**1.0172**

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DYNAMICS OF AIR-SEA INTERACTION ...Heat and Radiation Transfer, Meteorological Studies, Particle-gas Transfer, Profiles, Wind-water Interaction, ...**3.0022**
PROPAGATION AND REFRACTION OF OCEAN WAVES IN NEAR SHORE REGIONS ...Forecasting-prediction, Mathematical Analysis, Operational Aspect, Waves, ...**2.0117**
AIR-SEA INTERACTION (WAVES) ...British West Indies, Forecasting-prediction, Heat and Radiation Transfer, Waves, Wind-water Interaction, ...**3.0016**
MEDITERRANEAN OCEANOGRAPHY ...Convection, Data Analysis - General, Heat and Radiation Transfer, Mediterranean Sea-general, Ships and Cruises, ...**4.0132**
REMOTE SENSOR OCEANOGRAPHY ...Aerial Photography, Cloud Temperature, Gulf of Mexico, Infrared Radiation, Satellites, Temperature, ...**4.0170**
ACOUSTIC SCATTERING ...Acoustical, Interfaces, Model Studies, Reflection, Scattering, ...**1.0069**
NOISE LIMITATION UPON AEROMAGNETIC MEASUREMENTS ...Airborne Probing, Geomagnetic Field, Magnetic Sensor, Magnetometers, Noise, ...**8.0097**
OCEAN DYNAMICS SEA AIR INTERACTION MODELS-MEDITERRANEAN ...Acoustical, Hydrodynamics, Mediterraneun Sea-general, Model Studies, Wind-water Interaction, ...**3.0002**
OCEAN DYNAMICS - OCEANOGRAPHIC ANALYSES AND FORECASTING MODELS ...Acoustical, Air-sea Boundary-general, Hydrodynamics, Model Studies, Temperature, ...**1.0004**

PHYSICAL OCEANOGRAPHY ...Temperature, Transmission, Velocity, Waves, ...**1.0026**
INTERNAL WAVE STUDIES ...Acoustical, Model Studies, Refraction, Scattering, Waves-internal, ...**1.0021**
ELECTROMAGNETIC NOISE MEASUREMENTS IN THE S[illegible] ...Benthonic-bottom, Depth, Electromagnetic, Subm[illegible] ...**1.0138**
INTERNAL WAVE RESEARCH ...Acoustical, Tides, Waves, Waves-internal, ...**2.0096**
SHALLOW WATER OCEANOGRAPHY ...Acoustical, Continental Shelf, Hydrodynamics, Rhode Island, Transmission, ...**1.0030**

MEASUREMENT AND PREDICTIVE STATISTICS OF REVERBERATION ...Acoustical, Geomorphology-topography, Reverberation, Scattering, Textures-structures, Velocity, ...**1.0007**
BOTTOM-REFLECTED SONAR STUDIES ...Acoustical, Benthonic-bottom, Scattering, Sonar, Transmission, ...**1.0025**
EFFECT OF TEMPERATURES AND CIRCULATION OF CONTINENTAL SHELF WATERS ON THE DISTRIBUTION OF FISHES ...Continental Shelf, Fish -non-specific, Temperature, Water Movement, Currents,, Water Temperature-non-specific, ...**4.0165**
OPERATIONAL EVALUATION OF NSRT SYSTEM ...Equipment, Special Mission Ships, Temperature, ...**8.0059**

Survey Studies

ECOLOGICAL STUDY OF DUXBURY BAY ...Aquatic Ecology, Bays, Habitat Studies, Massachusetts, Tides, ...**5.0898**
DEEP OCEAN TECHNOLOGY ...Continental Shelf, Diving and Scuba, Technique Development, ...**8.0049**
OCEANIC FISHES OF THE TROPICAL ATLANTIC ...Atlantic Ocean-south, Fish -non-specific, Tropic, Vertical Distribution, ...**5.0068**
SURVEY OF MAINE LAW AFFECTING MARINE DEVELOPMENT ...Legal Review, Legal Studies-general, Maine, Marine Biology (non-specific), State Government, Water Law-general, ...**10.0002**
CETACEA OF TIERRA DEL FUEGO ...Facilities, Mammals, Tierra Del Fuego, Travel Grants, ...**5.0544**
THE STATUS AND POTENTIAL OF AQUACULTURE ...Algal Culture, Aquaculture & Fish-farming, Fish -non-specific, Food Supply, ...**8.0003**
SENSING OF ENVIRONMENT ...Remote Sensing-general, ...**4.0164**
SHALLOW-WATER ACOUSTICS ...Acoustical, Transmission, ...**1.0050**
SEA SURVEY INVESTIGATIONS ...California Current, Fish -non-specific, Population Dynamics, Vertical Distribution, ...**4.0117**
POTENTIAL FISHERY FOR RIVER HERRINGS IN CONNECTICUT RIVER ...Alewife,menhaden,shad,herring, Connecticut River, Data Acquisition, Life History Studies, Nets, Spawning & Nesting Sites, ...**5.0202**
KVICHAK RIVER SMOLT STUDY LITERATURE SURVEY ...Alaska, Censusing, Fish -non-specific, Migration, Number Or Density, ...**5.0003**
COLLECTION AND SURVEY OF NORTH CAROLINA MARINE AND ESTUARINE MOLLUSCA ...Collections, Estuaries, Mollusks -non-specific & Other, North Carolina, ...**5.0480**
THE THERMODYNAMIC PROPERTIES OF NITROGEN-OXYGEN MIXTURES ...Critical, Enthalpy, Entropy, Nitrogen, Oxygen, State Equations, ...**8.0025**
USE OF TIDAL POWER AND OTHER OCEAN ENERGY SOURCES ...Bibliography, Economics, Engineering Studies-other, Mechanical Power-other, Tides, ...**2.0084**
FUNDAMENTAL PROBLEMS IN HYDRODYNAMICS ...Convection, Hydrodynamics, Ordnance, Waves, Waves-internal, ...**2.0102**
BIOTA OF THE RED SEA AND EASTERN MEDITERRANEAN ...Marine Biology (non-specific), Migration, Red Sea, ...**5.0691**
GREAT LAKES RESEARCH - RIVER ICE JAMS ...Great Lakes-general, Ice Jam, Streams, Water Motion, ...**3.0081**
LABORATORY STUDIES TO DETERMINE ROCK PROPERTIES UNDER HYDROSTATIC (SEA WATER) PRESSURE ...Environmental Effects-geologic, Marine Environments-general, Physical Properties, Rock Mechanics, ...**8.0330**
EVALUATION OF CONTEMPORARY ACOUSTIC, MAGNETIC AND GRAVIMETRIC METHODS FOR DETERMINING SIZE AND SHAPE OF DEPOSITS ...Geophysical Equipment, Gravity Studies, Instrumental Services, Magnetic Studies, Sonar, ...**7.0007**
LITERATURE SEARCH AND PRELIMINARY ENGINEERING STUDIES OF ENVIRONMENTAL PROBLEMS ASSOCIATED WITH MARINE DEPOSIT DELINEATION TECHNIQUES ...Currents-ocean, Drilling Operation, Oil and Natural Gas - Sulfur, Wave Action, ...**8.0251**
EXPLORATION OF LATENT RESOURCES ON THE CONTINENTAL SHELF/SLOPE ...Atlantic Ocean-north, Commercial Fishing, Continental Shelf, Nets, ...**5.0102**
SURVEY, EVALUATION & SUMMARIZATION OF LITERATURE ON ENVIRONMENTAL REQUIREMENTS OF MARINE ORGANISMS LEVELS OF POTENTIAL TOXICANTS (ABBREV ...Biology, Chemical, Environmental Effects-geologic, Geosciences, Library, Marine Biology, Marine Environments-general, ...**4.0037**

Surveying

Computations

Area

DEVELOPMENT OF AN ADVANCED MISSILE IMPACT LOCATING SYSTEM FOR THE EASTERN TEST RANGE ...Acoustical, Atlantic Ocean-north, Missile & Rockets, Navigation, Sound Gear, ...**8.0048**
NAVIGATION SYSTEMS FOR SURVEY APPLICATIONS ...Instrumentation, Navigation, Technique Development, ...**4.0101**

Control Networks

Plane

OYSTER LEASE CONTROL MONUMENTS - BAY ADAM, BASTIAN BAY AND SANDY POINT BAY AREAS ...Commercial Fishing, Gulf of Mexico, Louisiana, Oysters, Tides, ...**4.0057**

Maps

Compilation

ANALYSIS AND DISPLAY OF HYDROGRAPHIC DATA ...Charts, Hydrographic, Reproduction, ...4.0022

Photogrammetry

HIGH FREQUENCY OCEAN WAVES ...Aircraft, Forecasting-prediction, Radar, Waves, Wind-water Interaction, ...2.0121

A RECONNAISSANCE OF COASTAL EROSION IN NORTH CAROLINA ...Aerial Photography, Beach, Development, Erosional Features, North Carolina, Reconnaissance, Shoreline - Coastline, Waves, ...7.0268

Reproduction

ANALYSIS AND DISPLAY OF HYDROGRAPHIC DATA ...Charts, Compilation, Hydrographic, ...4.0022

HYDROGRAPHIC SURVEY TECHNIQUES ...Bathymetry, Hydrographic, Technique Development, ...8.0089

Measurements

Instrumentation

SPACECRAFT OCEANOGRAPHY ...Instrumentation-general, Management, Photography, Satellites, Unmanned Satelite, ...4.0157

NAVIGATION SYSTEMS FOR SURVEY APPLICATIONS ...Area, Navigation, Technique Development, ...4.0101

Methods

Aerospatial

MARINE PHYSICAL GEODESY ...Caribbean Sea, Gravity Studies, Navigation, Sea Level Variations, Standard Geoid, ...4.0058

GREAT LAKES RESEARCH - ICE COVER DISTRIBUTION ...Aerial Photography, Alteration, Great Lakes-general, Petrofabrics, Sea Ice, ...3.0083

Survey Types

Hydrographic

DEPTH CONTROLLED STREAMER DEVELOPMENT ...Control-systems, Depth, Equipment, Sonar, ...8.0139

AN IMPROVED MARINE VIBROSEOS INSTALLATION ...Data Acquisition, Sonar, Special Mission Ships, ...8.0166

ANALYSIS AND DISPLAY OF HYDROGRAPHIC DATA ...Charts, Compilation, Reproduction, ...4.0022

HYDROGRAPHIC SURVEY TECHNIQUES ...Bathymetry, Reproduction, Technique Development, ...8.0089

Reconnaissance

A RECONNAISSANCE OF COASTAL EROSION IN NORTH CAROLINA ...Aerial Photography, Beach, Development, Erosional Features, North Carolina, Photogrammetry, Shoreline - Coastline, Waves, ...7.0268

Suspension-release

WATER-TO-AIR RETRIEVAL ...Aircraft, Mathematical Models, Recovery Operations, ...8.0276

Swamps-marshes

FIELD EXPERIMENTS ON THE FLUX OF RADIONUCLIDES THROUGH A SALT MARSH ECOSYSTEM ...Chlorideae (non-specific & Ot), Georgia, Model Studies, Productivity - Food Chain, Water Cycle, ...5.0965

DRAINAGE PATTERN DEVELOPMENT ON TIDAL MARSHES ...Aerial Photography, Drainage, Tides, ...7.0291

AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE - LABORATORY PROCEDURES ...Colorimetry, Computer Applications, Conductrometry, Management, Nitrogen, Phosphate, Phosphite, ...5.0761

AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE ...Management, Nitrate, Nitrite, Phosphate, Phosphite, Tidewater Areas, Water Properties-general, ...5.0953

CALORIC STUDIES OF SPARTINA AND THE MARSH CRAB SESARMA RETICULATUM ...Calorimetry, Chlorideae (non-specific & Ot), Crabs, Energy Budgets, ...5.0380

BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SALT MARSH ENVIRONMENT -...Identification, Marine Bacteria, Microbiological Analysis, Salinity, Temperature, ...5.0762

BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SALT MARSH ENVIRONMENT -...Aquatic Soils, Core Analysis, Identification, Marine Bacteria, Salinity, Temperature, Water Level Fluctuation, ...5.0763

PRODUCTIVITY STUDIES IN NORTH CAROLINA SALT MARSHES ...Aerial Photography, Mapping, North Carolina, Primary Productivity, Productivity - Food Chain, Tidewater Areas, ...5.1017

FACTORS EFFECTING RATES OF ORGANIC DEPOSITION AND QUALITY OF WATER ...Clays, Lake Ontario, Organic Digestion, Organic Matter, Rate of Deposition, ...7.0261

ECOLOGY OF MARSH FORAMINIFERA ...Foraminifera, Lagoons, Productivity - Food Chain, Rate of Deposition, ...5.0747

TIDE MARSH ECOLOGY AND WILDLIFE ...Management, Microorganisms (non-specific), Nitrogen Cycle, Nutrients, Phosphorus, Primary Productivity, ...5.0870

PALEOSALINITY DETERMINATION BY THE BORON IN ILLITE METHOD ...Boron, Illinois, Illite, Interstitial - Connate Water, Salinity, ...7.0238

EFFECTS OF MARSH MANAGEMENT STRUCTURES UPON FISHES ...Alewife,menhaden,shad,herring, Crabs, Engineering Structures-general, Land Use, Shrimps - Common, Spawning & Nesting Sites, ...5.0206

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...Bioassay, Estuaries, Persistance of Residues, Pollution - Effects of , Sevin, ...5.0918

REMOTE SENSING, EVERGLADES AREA, FLORIDA ...Computer Applications, Florida, Remote Areas, Visible Light, Water Properties-general, ...4.0161

EVALUATION OF ENGINEERING PROJECTS AND ESTUARINE DATA (ESTUARINE PROGRAM) ...Commercial Fishing, Engineering Structures-general, Estuaries, Gulf of Mexico, Habitat Studies, ...9.0021

Synthetic Hydrology

DYNAMIC MODEL STUDY OF LAKE ERIE ...Hydraulics-general, Inflow, Lake Erie, Model Studies, ...4.0075

POLLUTION STUDY OF THE VENICE DISTRICT CANAL ...California, Canals, Model Studies, Water Quality-general, ...6.0141

EFFECTS OF SCALE AND OPERATING TECHNIQUE ON HARBOR MODELS ...Harbors, ...4.0074

GENERAL COASTAL INLET STUDIES ...Coastal Engineering-other, Coastlines-shorelines, Discharge, Model Studies, Tides, Water Motion, ...7.0125

DISPERSION PROCESSES IN ESTUARIES AND RIVERS ...Dispersion -water, Dyes, Estuaries, Streams, ...2.0050

Systems Analysis

SYSTEMS ANALYSIS ASSISTANCE TO HEADQUATERS U. S. COAST GUARD ...Benefit-cost Analysis, Model Studies, Sea Ice, Ships and Cruises, ...12.0015

SURFACE AND GROUND WATER POTENTIALITIES OF THE MULLICA RIVER BASIN ...Aqueducts, Conjunctive Use, Economic Impact, Estuaries, Water Quality-general, Water Transfer, ...9.0014

TECHNIQUES OF PLANNING ...Application, Control Systems, Management, Mathematical Analysis, Operations Research, Planning, Southern, ...9.0017

FATE OF INLAND DERIVED POLLUTANTS IN AN ESTUARY ...Estuaries, Pollutants - Path of , Pollution - Effects of , Pollution Abatement, Pollution Sources-general, ...6.0133

Tank, Pressure Vessel

CONSTRUCTION OF A FACILITY TO DEMONSTRATE OFFSHORE UNDERWATER TEMPORARY STORAGE OF STORM OVERFLOW FROM A COMBINATION SEWER ...Combined Sewer, Elastomers, Rubber, Lake Erie, Storm Water, Water Storage, ...8.0328

Tape Recording, Audio

ACOUSTIC RECORDING OF MARINE MAMMALS OF NOVA SCOTIA AND NEWFOUNDLAND ...Atlantic Ocean-north, Canada, Mammals, Seals, Sound Production, ...5.0625

Tape Recording, Audio

BEHAVIOR AND SENSORY PHYSIOLOGY OF SHARKS ...Auditory, Behavioral Ecology, Fish Repellents, Sharks, Visual Organs, ...5.0253

BELUGA WHALES ...Acoustical, Behavioral Ecology, Life History Studies, Mammals, Sound Production, ...5.0527

Teaching and Research

COOPERATIVE RESEARCH AND RESEARCH TRAINING PROGRAM IN BIOLOGICAL OCEANOGRAPHY ...Marine Biology, Ships and Cruises, ...12.0040

INVESTIGATIONS IN MARINE BIOLOGY ...Marine Biology, Massachusetts, ...11.0027

RESEARCH-TRAINING COURSE IN OCEANOGRAPHY IN SOUTHEAST ALASKA ...Alaska, Oceanography-general, ...12.0001

UNDERGRADUATE RESEARCH PARTICIPATION ...Oceanography-general, ...11.0017

APPLIED MARINE ENGINEERING PROGRAM AT SCRIPPS INSTITUTION OF OCEANOGRAPHY ...California, Engineering Studies-general, Harbors, Marine Biology, Marine Biology (non-specific), Other-design-and-construction, Scientific-service-support, Training Grants, Fellowships, ...11.0006

RESEARCH VESSEL U.S.N.S ELTANIN ...Antarctica, Equipment Purchase Operation, Geophysics-general, Scientific-service-support, Special Mission Ships, ...12.0036

METEOROLOGICAL SUPPORT OF DEEP-SEA DRILLING OPERATIONS ...Coring and Dredging, Drilling and Coring, Meteorological Studies, Waves, Weather Forecasting, ...12.0013

PARTICIPATION IN USARP EXPEDITIONS ...Antarctica, Data Acquisition, Data Analysis - General, Marine Biology, Ships and Cruises, ...12.0012

A PROGRAM FOR THE TRAINING OF STAFF MEMBERS FROM THE SCHOOL OF FISHERIES OF THE CATHOLIC UNIVERSITY OF VALPARAISO CHILE ...Chile, Fish -non-specific, Food Processing Industry, Marine Biology, ...5.0181

Technique Development

ACOUSTIC IMAGE INVESTIGATION ...Acoustical, Reflection, Sonar, ...1.0018

FEASIBILITY STUDY FOR A GATED-LASER, IMAGE-AMPLIFIER UNDERWATER VISION SYSTEM ...Electric Lighting Systems, Image Converters, Lasers-masers, Optical Devices, Photography, ...8.0108

EXPERIMENTAL VERFICATION OF WIDE SWATH OCEAN BOTTOM CONTOURING WITH SPLIT BEAM RECEIVERS ...Bathymetry, Caribbean Sea, Receivers, Sonar, Topographic, ...7.0302

INVESTIGATE METHODOLOGY FOR MEASURING OCEANIC PROPERTIES LEADING TO THE TOTAL ENVIRONMENTAL SURVEY OF A SELECTED OCEAN AREA ...Coring and Dredging, Oceanic - Pelagic, Physical Properties, Radioactivity, Submersibles, ...8.0061

DEEP SUBMERGENCE VEHICLES - DYNAMIC ANALYSES ...Data Acquisition, Experiments and Tests, Mathematical Analysis, Model Studies, Submersibles, Underwater-laboratory, ...8.0264

RESEARCH SUBMARINE BEAVER MK IV ...Control-systems, Diving and Scuba, Scientific-service-support, Submersibles, Underwater-laboratory, ...8.0265

DEEP OCEAN TECHNOLOGY ...Continental Shelf, Diving and Scuba, Survey Studies, ...8.0049

LIFE SUPPORT RESEARCH ...Divers, Diving and Scuba, Medical Studies, Subsurface Environments, ...8.0027

PRECISION QUARTZ CAPACITANCE PRESSURE TRANSDUCERS ...Capacitance, Pressure, Quartz, Transducers, ...8.0121

PREDICTION OF EXTREME ENVIRONMENTAL FACTORS ...Forecasting-prediction, Meteorological Extremes, Statistics-general, Waves, Wind-general, ...4.0048

UTILIZATION OF SYNCHRONOUS SATELLITE DATA ...Height Ceiling, Patterns, Satellites, Velocity, Weather Forecasting, ...4.0173

OIL LEAKS AND SLICKS ...Aerial Photography, Aircraft, Oil, Pollutants-other, Satellites, ...4.0145

SATELLITE SEA ICE STUDIES USING HRIR ...Arctic Ocean, Data Analysis - General, Infrared Radiation, Satellites, Sea Ice, ...3.0075

FLIGHT TESTING OF HIGH PERFORMANCE WIDE-RANGE IMAGE SPECTROPHOTOMETER (WISP) SYSTEM ...Aircraft, Optical, Spectral Reflectance, ...4.0152

INFRARED RADIOMETRY FOR SURFACE HEAT FLOW ...Atmosphere Radiation, Heat and Radiation Transfer, Heat Exchange, Infrared Radiation, Temperature, ...4.0153

DESIGN AND DEVELOPMENT OF OCEANOGRAPHIC INSTRUMENTATION ...Bottom Sampling Device, Physical Analysis, Water Motion Recorders, ...8.0090

SEA WATER CHEMISTRY ...Atmosphere Composition, Gases, Industrial-general, Lead, Trace Elements, ...1.0076

DEVELOPMENT AND EVALUATION OF A NEW TECHNIQUE FOR SAMPLING ZOOPLANKTON ...Organism Sampling Devices, Population Dynamics, Productivity - Food Chain, Vertical Distribution, Zooplankton, ...5.0786

HOLOGRAPHIC INSTRUMENTATION FOR MARINE PLANKTON STUDIES ...Lasers and Masers, Photography, Zooplankton, ...8.0066

DEVELOPMENT OF AN INSTRUMENT FOR MEASURING THE CONCENTRATION OF DISSOLVED OXYGEN IN SEA WATER IN SITU ...Chemical Analysis (water), Gases, Instrumental Services, Oxygen, Telemetry-other, ...8.0092

TEMPERATURE MICROSTRUCTURE AT THE OCEAN FLOOR ...Heat Flow Measurements, Instrumental Services, Oregon, Physical Properties, Temperature, ...1.0188

DETERMINATION OF VOLATILE ORGANICS IN SEA WATER ...Chemical Analysis (water), Gas Chromatography, Organics, Organics-general, Water Analysis, ...1.0094

GEOTHERMAL INVESTIGATIONS IN OCEAN REGIONS ...Atlantic Ocean-general, Geothermal, Heat Flow Measurements, Model Studies, Regional Structure, ...7.0121

MARINE GRAVITY ...Analog Computer Applications, Geophysical Equipment, Gravity Studies, Navigation, Satellites, Ships and Cruises, ...7.0128

HEAT FLOW MEASUREMENTS ...Atlantic Ocean-general, Geophysical Equipment, Heat Flow Measurements, Photography, Water Motion Recorders, ...7.0138

GEOTHERMAL STUDIES IN DEEP-SEA DRILL HOLES ...Abyssal, Bathyal, Borehole Geophysics, Core Temperature, Earth Interior, Geothermal, Heat Flow Measurements, Heat Flows, Sediments-general, ...7.0122

RADAR SCATTERING ...Radar, Waves, ...4.0103

INSTRUMENT DEVELOPMENT ...Navigation, Oxygen, Satellites, ...8.0065

AIR OCEANOGRAPHY ...Air-sea Boundary-general, Atlantic Ocean-north, Buoys, Gulf Stream, Satellites, ...4.0163

MARINE GRAVITY ...Dynamic Gravimeters, Geophysical Equipment, Navigation, Ships and Cruises, ...8.0101

TELEMETERING BUOY SYSTEM FOR OCEANOGRAPHIC RESEARCH AND ENIVRONMENTAL PREDICTION ...Buoys, Data Acquisition Systems, Meteorological Studies, Moorings, Navigation Communication, Oceanography-general, Telemetry-other, ...8.0268

OCEAN DYNAMICS EXPERIMENTS ...Buoys, Moorings, Other-design-and-construction, Submersibles, Temperature, Water Motion Recorders, ...2.0072

UNDERWATER HOLOGRAPHIC IMAGING ...Holography, Imaging, Photography, ...8.0069

SUPERCONDUCTING MAGNETOMETER SYSTEMS EVALUATION ...Aircraft, Magnetometers, Superconducting Magnets, ...8.0098

ACOUSTIC LUNEBERG LENS ...Liquids, ...8.0054

MARINE LABORATORY ...Fishing Gear, Laboratory Analysis, Louisiana, Nets, Organism Sampling Devices, ...11.0024

DELAWARE ESTUARY AND BAY WATER QUALITY SAMPLING AND MATHEMATICAL MODELING PROJECT ...Data Analysis - General, Delaware Bay, Mathematical Analysis, Model Studies, Pollution Abatement, ...6.0163

DEVELOPMENT OF ANALYSIS TECHNIQUES AND EQUIPMENT FOR CLASSIFICATION OF TRANSIENT HYDROACOUSTIC SIGNALS ...Acoustical, Real Time Systems, Sonar, ...1.0070

DEEP SEA MINING PROJECT ...Dredging, Equipment, Ocean Mining, Scientific-service-support, ...8.0259

AEROLOGICAL INSTRUMENTS ...Amplifiers, Field Testing, Humidity Instruments, Instrumental Services, Microwave Techniques, ...8.0082

FOSDIC APPLICATION TO CURRENT-METER RECORDS ...Currents-ocean, Data & Statistics Storage, Recording Systems, Research - Development, Water Motion Recorders, ...4.0021

OBJECTIVE WEATHER ANALYSIS ...Research - Development, Tropic, Weather Forecasting, Wind-general, ...4.0042

RESEARCH FLIGHT FACILITY ...Aircraft, Equipment Purchase Operation, General Synoptic Observations, Tropical Cyclones, ...**4.0158**

SHIPBOARD METHODS OF CHEMICAL ANALYSIS ...Caribbean Sea, Gases, Mass Spectroscopy, Solubility, Water Analysis-general, ...**1.0091**

ACOUSTIC PROPAGATION STUDIES ...Acoustical, Instrumentation-general, Transmission, ...**1.0044**

HYDROGRAPHIC SURVEY TECHNIQUES ...Bathymetry, Hydrographic, Reproduction, ...**8.0089**

NAVIGATION SYSTEMS FOR SURVEY APPLICATIONS ...Area, Instrumentation, Navigation, ...**4.0101**

POWER SOURCES ...Benthonic-bottom, Power Transmission Systems, Safety, Submerged Ships, Underwater-construction, ...**8.0156**

PRECISE RADIO NAVIGATION FOR SHIPS ...Anti-submarine-warfare, Moorings, Navigation, Navigation Communication, ...**4.0099**

ONE ATMOSPHERE DIVERS SUIT ...Diving and Scuba, Diving-system, Life-support-system, ...**8.0020**

DIVER NAVIGATION DEVICE ...Bathymetry, Diving and Scuba, Diving-system, Navigation, ...**6.0131**

ANCHORS AND MOORINGS ...Moorings, Submersibles, Underwater-construction, ...**8.0334**

DEVELOPMENT OF DIAMOND DRILLING TECHNIQUES, FOR PHOSPHORITE DEPOSITS, USING STANDARD TOOLS PLUS BUOYANCY TANKS ...Bottom Sampling Device, Disturbed/undisturbed, Drilling and Coring, Phosphate, Soil Sampling, ...**8.0248**

DEVELOPMENT OF WIRE-LINE CORING TECHNIQUE FOR SAMPLING UNCONSOLIDATED DEPOSITS ...Alaska, Bottom Sampling Device, Coring and Dredging, Mechanical Properties, Mineralogy, ...**8.0249**

FEASIBILITY STUDY OF THE USE OF ELECTRICAL METHODS FOR DETERMINING SIZE AND SHAPE OF DEPOSITS ...Dimensions-distribution, Electric Logging, Instrumental Services, Methodology, Ocean Mining, ...**7.0008**

EVALUATION OF CONTEMPORARY PRECISION NAVIGATION SYSTEMS ...Bathymetry, Communication & Navigation, Navigation, Navigation Communication, Satellites, ...**4.0087**

DEVELOPMENT, TESTING AND EVALUATION OF MODIFICATIONS REQUIRED TO ADAPT DRILLING SAMPLING SYSTEMS TO THE PLATFORM ...Bottom Sampling Device, Coring and Dredging, Drilling and Coring, Equipment, Platforms, ...**8.0256**

DEVELOPMENT OF MARINE CHURN DRILL FOR SAMPLING UNCONSOLIDATED DEPOSITS ...Bottom Sampling Device, Drilling and Coring, Soil Sampling, Unconsolidated Deposits, ...**8.0250**

DEVELOPMENT OF AN ELECTRONIC METHOD FOR THE AUTOMATIC SHIPBOARD RECORDING OF DRILL PERFORMANCE DATA ...Data Acquisition, Data Acquisition Systems, Drilling and Coring, Non-electrical Measurements, Recording Systems, ...**8.0247**

LABORATORY MODEL STUDIES OF PENETRATION INTO A SIMULATED COHESIONLESS DETRITUS ...Coring and Dredging, Gravel, Mechanical Properties, Model Studies, Soil Sampling, ...**8.0245**

EARLY LIFE HISTORY OF COREGONIDS ...Cisco, Lake Herring, Environmental Ecology, Life History Studies, Maturity & Growth Stages, Water Environment -other, ...**5.0110**

PILOT STUDY OF LIMITED PORTION OF TRADE WIND ZONE OCEANOGRAPHY (DATA AND DESCRIPTIVE REPORTS) ...Environmental Changes, Oceanic Fronts, Pacific Ocean-north, Water Properties-general, ...**4.0129**

ANALYZE AND PUBLISH BASIC DATA FROM PILOT STUDY ...Environmental Changes, Oceanic Fronts, Pacific Ocean-general, Salinity, Thermal, ...**4.0024**

CHEMICAL OCEANOGRAPHY ...Aquatic Ecology, Circulation-general, Convection, Trace Elements, ...**1.0134**

INCREASE EFFICIENCY OF HAWAIIAN LONGLINE FISHERY ...Commercial Fishing, Fish & Shellfish, Fishing Gear, Hawaii, Production & Processing, Technological Development, ...**11.0022**

DEVELOPMENT OF A METHOD FOR CHRONIC TOXICITY BIOASSAY USING MARINE PLANKTONIC ALGAE ...Algal Culture, Bioassays, Marine Plants, Microbiological Analysis, Monitoring (long Term Studies), Phytoplankton, Toxicology, ...**5.0726**

Techniques

Diffraction

Electron

ELECTRON MICROSCOPE AND ELECTRON DIFFRACTION STUDIES OF GEOLOGICAL SAMPLES ...Electron Microscopy, ...**7.0278**

X-ray

RARE GAS STUDY OF INTERPLANETARY MATERIAL IN PELAGIC SEDIMENTS ...Chemistry, Cosmogenous, Element Ratios, Equipment Purchase Operation, Mass Spectroscopy, Mineralogy, ...**7.0081**

Electron Microscopy

ELECTRON MICROSCOPE AND ELECTRON DIFFRACTION STUDIES OF GEOLOGICAL SAMPLES ...Electron, ...**7.0278**

Telemetry

BIOTELEMETRY ...Instrumental Services, Marine Biology, Marine Biology (non-specific), ...**8.0070**

APPLICATION OF BIOTELEMETRY TO THE STUDY OF MARINE VERTEBRATES ...Biological Sciences, Central Nervous System, Fish -non-specific, Locomotion -animal, Telemeters, ...**5.0637**

Converters - Coders

SUBMERGED OPERATIONS COMMUNICATIONS (SUBCOM) ...Diving and Scuba, Waveform, ...**8.0023**

Receivers

EXPERIMENTAL VERFICATION OF WIDE SWATH OCEAN BOTTOM CONTOURING WITH SPLIT BEAM RECEIVERS ...Bathymetry, Caribbean Sea, Sonar, Technique Development, Topographic, ...**7.0302**

EXPERIMENTAL HIGH RESOLUTION SUB-BOTTOM PROFILING SYSTEM ...Amplifiers, Sonar, Sonar and Echo Sounding, Subbottom, Transducers, ...**8.0109**

Telemetry-other

STUDY OF PROBABILITY OF DETECTION AND FALSE ALARM RATE OF FREQUENCY ACOUSTIC TELEMETERING SYSTEM ...Acoustical, Interference, Oil and Natural Gas - Sulfur, ...**8.0106**

DEVELOPMENT OF AN INSTRUMENT FOR MEASURING THE CONCENTRATION OF DISSOLVED OXYGEN IN SEA WATER IN SITU ...Chemical Analysis (water), Gases, Instrumental Services, Oxygen, Technique Development, ...**8.0092**

MARINE ATMOSPHERIC RESEARCH FACILITY ...Air-sea Boundary-general, Instrumental Services, Meteorological Studies, Platforms, Turbulence, Weather Modification-general, ...**8.0322**

STUDIES OF EARTHQUAKES IN THE CAPE MENDOCINE AREA ...Applied Electronics, Data Transmission Systems, Earthquake Location, Earthquakes, Seismic Studies, ...**7.0088**

SATELLITE COMMUNICATION TESTS ...Buoys, Forecasting-prediction, Marine Environments-general, Satellites, Very High Frequency, ...**4.0001**

TELEMETERING BUOY SYSTEM FOR OCEANOGRAPHIC RESEARCH AND ENIVRONMENTAL PREDICTION ...Buoys, Data Acquisition Systems, Meteorological Studies, Moorings, Navigation Communication, Oceanography-general, Technique Development, ...**8.0268**

OCEAN SYSTEM TELEMETRY STUDY ...Applied Electronics, Buoys, Data Acquisition, Data Transmission Systems, Moorings, ...**4.0002**

OCEAN ENGINEERING ...Bathymetry, Commercial Fishing, Fishing Gear, Instrumental Services, ...**8.0152**

COAST GUARDS COASTAL OCEANOGRAPHIC MONITORNG NETWORK ...Automatic Stations, Buoys, Instrumental Services, Recording Systems, Transducers, ...**4.0006**

Temperature Effects

HELIUM - HEAT TRANSFER ...Air, Diving and Scuba, Heat Transfer, Helium, Submersibles, ...**8.0201**

Terpenes

FORMATION AND UTILIZATION OF TERPENES ...Anthozoa, Biosynthesis, Enzyme-substrate, Symbiosis, Zooxanthella, ...5.0957

Testing Facilities

ADVANCE SONAR SYSTEMS ...Data Display, Instrumental Services, Sonar, Sonar and Echo Sounding, Transducers, ...8.0096

INSTRUMENT STUDIES ...Electronic Components-other, Evaluation Other, Instrumental Services, ...8.0104

ENVIRONMENTAL TEST AND EVALUATIO [illegible] oustic, Transducers, Ultrasonic Technology, ...8.0128

Texas

SEA BREEZE INVESTIGATION ...Data Analysis - General, Energy-general, Gulf of Mexico, Heat and Radiation Transfer, Land-sea Breezes, ...3.0040

SUBSURFACE RESISTIVITY ...Crust, Earth-telluric Current, Magnetic Surveys, Ocean Basins, Resistance, ...7.0147

A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY ...Commercial Fishing, Estuaries, Mans Activities, Pollution - Effects of , Spawning & Nesting Sites, ...5.0926

EFFECTS OF RIVERS ON THE METABOLISM OF TEXAS BAYS ...Bays, Nutrients, Pollutants-general, Primary Productivity, Streams, Water Quality-general, ...6.0187

STUDY OF LIFE HISTORY AND ECOLOGY OF SERPULIDAE IN TEXAS COASTAL WATERS ...Gulf of Mexico, Life History Studies, Lugworms, Marine Segmentedworm, ...5.0656

COASTAL PROCESSES - SOUTH TEXAS ...Depositional Features-other, Distribution, Other Transport Methods, Rate of Deposition, Shoreline - Coastline, ...7.0219

Theoretical Analysis

A STUDY OF PROBLEMS RELATED TO WIND-GENERATED WAVES ...Free Surface Waves, Laminar - Turbulent, Waves, Wind-water Interaction, ...4.0088

DYNAMICAL OCEANOGRAPHY AND GEOPHYSICAL FLUID DYNAMICS ...Acoustic Effects, Circulation-general, Forced Convection, Thermal, Water Tunnels Tables, ...2.0012

HYDRODYNAMIC EFFECTS OF SUBMERGED BODY ...Air-sea Boundary-general, Fluid Dynamics, Model Studies, Water Tunnels Tables, ...8.0179

Thermal Properties

DIELECTRIC MATERIALS ...Dielectric Materials, Organometallic, Submersibles, ...8.0215

Critical

THE THERMODYNAMIC PROPERTIES OF NITROGEN-OXYGEN MIXTURES ...Enthalpy, Entropy, Nitrogen, Oxygen, State Equations, Survey Studies, ...8.0025

RESEARCH AND COMPUTATIONS ON THE THERMODYNAMIC PROPERTIES OF AIR AND RELATED GASES ...Air, Free Energy, Hydrogen, Virial Coefficient, ...3.0014

Expansion

PROPERTIES OF SEA WATER ...Compressibility--gas-liq, Conductivity, Density, Electrical, Physical Analysis, Thermal, ...1.0153

THERMAL PROPERTIES OF SEA WATER AT LOW TEMPERATURE AND HIGH PRESSURE ...Acoustical, Conduction, Hydrodynamics, Physical Analysis, Thermal, ...1.0177

Heat Capacity

Specific Heat

OXYGEN PROPERTIES ...Density, Liquid Propellant Rock, Oxidizers, Oxygen, State Equations, Thermodynamic Relation, ...8.0174

Thermal Properties-other

ELECTROLYTE-NON-ELECTROLYTE INTERACTIONS IN SEA WATER AND RELATED SOLUTIONS ...Alkali Metals, Alkaline Earths, Complexes, Electrolytes, Saline Water Systems, Water Analysis-general, ...1.0107

Thermochemical Heat

Solution

PHYSIOCHEMICAL AND ACOUSTIC PROPERTIES OF SEA WATER ...Acoustical, Electrical, Saline Water Systems, Thermal, ...1.0157

Thermodynamic Relation

OXYGEN PROPERTIES ...Density, Liquid Propellant Rock, Oxidizers, Oxygen, Specific Heat, State Equations, ...8.0174

Compressibility--gas-liq

PROPERTIES OF SEA WATER ...Conductivity, Density, Electrical, Expansion, Physical Analysis, Thermal, ...1.0153

Enthalpy

THE THERMODYNAMIC PROPERTIES OF NITROGEN-OXYGEN MIXTURES ...Critical, Entropy, Nitrogen, Oxygen, State Equations, Survey Studies, ...8.0025

Entropy

THE THERMODYNAMIC PROPERTIES OF NITROGEN-OXYGEN MIXTURES ...Critical, Enthalpy, Nitrogen, Oxygen, State Equations, Survey Studies, ...8.0025

Equations

State Equations

THE THERMODYNAMIC PROPERTIES OF NITROGEN-OXYGEN MIXTURES ...Critical, Enthalpy, Entropy, Nitrogen, Oxygen, Survey Studies, ...8.0025

OXYGEN PROPERTIES ...Density, Liquid Propellant Rock, Oxidizers, Oxygen, Specific Heat, Thermodynamic Relation, ...8.0174

Equilibrium - Chemical

OCEAN-ATMOSPHERE STUDIES WITH STABLE ISOTOPES AND DISSOLVED GASES ...Air-sea Boundary-general, Gases, Mixing, Oceanic Fronts, Particle-gas Transfer, Tracers, ...3.0005

PHASE RELATIONS OF THE HYDRATED CARBONATES OF CALCIUM AND MAGNESIUM ...Carbonate, Bicarbonate, Interfacial, Phase Relationships, Properties and Structure, Surface Chemistry, ...3.0085

RESEARCH ON THE PHYSICAL CHEMISTRY OF CHEMICAL REACTIONS IN SEA WATER ...Acids, Apatite-general, Carbonate, Bicarbonate, Chemical Reactions, High Pressure Research, Reaction-general, Solubility, Sulfate, Sulfite, ...1.0127

SOLUTION-SILICATE REACTIONS AND EQUILIBRIA ...Chemical Reactions, Chemistry, Groundwater, Reaction-general, Silicate-general, Solution, Solution Chemistry, ...1.0097

Free Energy

RESEARCH AND COMPUTATIONS ON THE THERMODYNAMIC PROPERTIES OF AIR AND RELATED GASES ...Air, Critical, Hydrogen, Virial Coefficient, ...3.0014

State Variables - Pvt

VISCOSITY AND VISCOELASTICITY OF LIQUIDS AND GLASSES ...Glass, Instrumental Services, Liquid, Morphology, Viscoelasticity, Viscosity, ...8.0260

Virial Coefficient

RESEARCH AND COMPUTATIONS ON THE THERMODYNAMIC PROPERTIES OF AIR AND RELATED GASES ...Air, Critical, Free Energy, Hydrogen, ...3.0014

Thin Sections

PALEONTOLOGICAL EVIDENCE OF CYCLES IN THE EARTH-MOON SYSTEM ...Comparative Studies-other, Environmental Changes, Invertebrates, Origins, Shells, Tides, ...7.0167

CONTRACT FOR-PROCESSING OF USARP ROCK SAMPLES ...Antarctica, Classifications, Collections, Coring and Dredging, Petrology, Sampling, Ships and Cruises, ...7.0060

Thorium

INVESTIGATIONS OF URANIUM AND THORIUM SERIES ISOTOPE DISEQUILIBRIUM IN THE OCEAN AND IN PLEISTOCENE SEDIMENTS ...Chemistry, Glacial History, Quaternary Period, Radioactivity, Radium, Uranium, ...1.0120

DEPOSITION RATES BY THE PROTACTINIUM METHOD ...Chemical, Distribution, Element Ratios, Manganese, Sedimentary Petrogenesis, Thermal, Uranium, ...7.0270

Tidal Streams

ESTUARINE SEDIMENTATION PROCESSES ...Estuaries, General Deposition, Intertidal Areas, Morphology-general, New England Province, Tides, ...7.0244

BIOLOGY OF ANADROMOUS ALOSIDS ...Alewife,menhaden,shad,herring, Mortality Rates, Spawning & Nesting Sites, Streams, Virginia, ...5.0150

FLUSHING PATTERN OF CERTAIN TIDAL STREAMS IN DELAWARE ...Aquatic Ecology, Circulation -water, Delaware, Discharge, Industrial-general, ...2.0013

EFFECTS OF HEATED WATER IN A TIDAL ESTUARY ...Chesapeake Bay, Electric Power Plants, Pollution - Effects of , Pollution Effects, Thermal Pollution, Water Properties-general, ...6.0145

PINK SALMON INVESTIGATIONS - INTERTIDAL ECOLOGY ...Alaska, Life History Studies, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, Water Salinity, ...5.0186

Tides

ECOLOGICAL STUDY OF DUXBURY BAY ...Aquatic Ecology, Bays, Habitat Studies, Massachusetts, Survey Studies, ...5.0898

A STUDY OF THE DEEP CIRCULATION AND DEEP FISH POPULATIONS IN THE PACIFIC OCEAN ...Currents-ocean, Fish -non-specific, Pacific Ocean-general, Vertical Distribution, ...2.0005

LONG PERIOD WAVES ...Fjords, Hydrodynamics, Iceland, Seiches, Waves, ...2.0108

OCEAN WAVES AND TIDES ...Currents-ocean, Subsurface Environments, Thermal, Water Motion Recorders, Waves, ...2.0080

ESTUARINE SEDIMENTATION PROCESSES ...Estuaries, General Deposition, Intertidal Areas, Morphology-general, New England Province, Tidal Streams, ...7.0244

SUPPORT OF THE VERMILION SEA FIELD STATION AT BAHIA DE LOS ANGELES, BAJA CALIFORNIA ...Arid and Desert, Facilities, Gulf of California, Habitat Studies, Temperature, ...12.0009

STUDIES OF BARACLINIC TIDAL MOTIONS ON THE CONTINENTAL SHELF OF THE EASTERN UNITED STATES ...Continental Shelf, Eastern, Meteorological Studies, Sea Level Variations, Water Motion, ...2.0081

DETERMINATION OF TIDES IN THE REAL OCEANS ...Forecasting-prediction, Numerical Analysis-other, Partial, ...2.0089

STUDY OF LOW FREQUENCY SURFACE WAVES IN THE PACIFIC OCEAN ...Meteorological Studies, Sea Level Variations, Turbulence - Sea Water, Water Motion Recorders, Waves, ...2.0068

THEORETICAL STUDY OF OCEAN TIDES FOR PURPOSES OF WORLDWIDE PREDICTION ...Earth Tides, Forecasting-prediction, Mediterranean Sea-other, Waves, ...2.0090

FIELD DETECTION AND MEASUREMENT OF INTERNAL WAVES ...Acoustical, Density, Digital Computer Applications, Temperature, Waves-internal, ...2.0125

OCEAN WAVES AND STRUCTURE ...Buoys, Salinity, Thermocline, Water Motion Recorders, Waves, ...2.0106

GRAVITY AND EARTH TIDES ...Antarctica, Earth Interior, Earth Tides, General Gravimeters, Propagation, ...2.0077

BOTTOM CURRENTS AND DEEP SEA TIDES ...Abyssal, Acoustical, Benthonic-bottom, Currents-other, Finite Differences, Model Studies, ...2.0004

INTERNAL WAVE STUDY ...Acoustical, Atlantic Ocean-north, Continental Shelf, Thermal, Waves-internal, ...2.0099

OYSTER LEASE CONTROL MONUMENTS - BAY ADAM, BASTIAN BAY AND SANDY POINT BAY AREAS ...Commercial Fishing, Gulf of Mexico, Louisiana, Oysters, Plane, ...4.0057

VERMILION - CALCASIEU - SABINE SYSTEM ...Benthic Fauna, Louisiana, Number Or Density, Plankton Sampling, Salinity, Vertical Distribution, ...5.0094

THE NET EFFECT OF WIND ON RECREATIONAL TIDAL STREAMS IN FLORIDA ...Air-sea Boundary-other, Estuaries, Florida, Water Level Fluctuation, Wind-general, ...2.0082

RESIDENCE TIMES OF WATERS BEHIND BARRIER ISLANDS ...Bays, Circulation-general, Simulation Theory, Wind-water Interaction, ...2.0018

ANNUAL PHYTOPLANKTON PRODUCTION IN PUGET SOUND WATERS ...Copepods, Invertebrate Culture, Phytoplankton, Puget Sound, Standing Crops, ...5.0931

SPECTRAL ANALYSIS OF TIDAL CURRENTS ...Currents-other, Hawaii, Integral Transforms, Prediction, Time Series Analysis, ...2.0083

A GLOBAL DIRECTORY OF TIDAL CONSTANTS ...Arcs, Maps-other, Tables, Compilations, Catalogs, ...2.0079

RECENT SEDIMENTATION BY TIDAL AND LONGSHORE CURRENTS ON A CARBONATE BANK IN LOWER FLORIDA KEYS ...Banks, Currents-longshore, Florida, Quaternary Period, Sedimentation, ...7.0253

USE OF TIDAL POWER AND OTHER OCEAN ENERGY SOURCES ...Bibliography, Economics, Engineering Studies-other, Mechanical Power-other, Survey Studies, ...2.0084

OXYGEN RESOURCES OF TIDAL WATERS ...Autotrophic, Marine Biology (non-specific), Oxygen, Oxygen Content -water, Pollution Sources-general, ...1.0119

GALVESTON BAY STUDY ...Estuaries, Numerical Analysis-other, Optimization, Simulation, Waste Water Treatment-general, ...4.0062

INTERNAL WAVE RESEARCH ...Acoustical, Surface Environments, Waves, Waves-internal, ...2.0096

TIDAL FLOWS IN RIVERS AND HARBORS ...Committee-support, Harbors, Hydraulics-general, Streams, ...2.0087

GENERAL COASTAL INLET STUDIES ...Coastal Engineering-other, Coastlines-shorelines, Discharge, Model Studies, Synthetic Hydrology, Water Motion, ...7.0125

SEDIMENT MOVEMENT AND BOTTOM CONDITIONS IN THE DELAWARE ESTUARY MOUTH AREA ...Bottom Sampling Device, Currents-other, Delaware Bay, Photography, Sedimentation, ...7.0220

FLOW AND SALINITY IN THE HUDSON ESTUARY, NEW YORK ...Estuaries, Fresh Water, Inflow, Management, Salinity, ...2.0075

REMOTE SENSING, GULF COASTAL AREA, CENTRAL FLORIDA ...Aircraft, Aquifers, Fresh Water, Saline Water Systems, Temperature, ...4.0160

EXTENT OF BRACKISH WATER IN TIDAL RIVERS, MARYLAND ...Brackish Water, Runoff, Water Utilization -general, ...1.0100

TIDAL DISCHARGE RESEARCH, NEW JERSEY ...Data Acquisition, Data Reduction and Analysis, Discharge, Sediments, Water Quality-general, ...2.0088

DESIGN, CONSTRUCTION AND LONGEVITY OF ARTIFICIAL FISHING REEFS ...Atlantic Ocean-north, Currents-ocean, Reefs, ...9.0013

TRACERS STUDIES IN ALASKAN HARBORS ...Estuaries, Flow Augmentation, Harbors, Industrial Wastes, Tracers-general, ...2.0049

Tidewater Areas

AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE ...Management, Nitrate, Nitrite, Phosphate, Phosphite, Swamps-marshes, Water Properties-general, ...5.0953

PRODUCTIVITY STUDIES IN NORTH CAROLINA SALT MARSHES ...Aerial Photography, Mapping, North Carolina, Primary Productivity, Productivity - Food Chain, Swamps-marshes, ...5.1017

EUTROPHICATION OF TIDAL WATERS ...Eutrophication, Growth and Differentiation, Model Studies, Nutrients, Photosynthesis, ...5.0909

SHOALING PROCESSES ...Channels, Sand Bars, Scouring, Sediment Transport-other, Turbulent Flow, ...7.0250

ESTURAINE ECOLOGY--INDIAN RIVER, DELAWARE ...Delaware, Estuaries, Water Environment -other, ...5.0875

Tierra Del Fuego

CETACEA OF TIERRA DEL FUEGO ...Facilities, Mammals, Survey Studies, Travel Grants, ...5.0544

Tissue Techniques

FREEZING AND DRYING OF LIVING CELLS ...Animal Nematodes -non-specific, Cell Injury and Autolysis, Cell. env.(non-specific & Ot.), Freeze-dry Techniques, Mollusks - non-specific & Other, ...5.0450

PHYSIOLOGICAL CHARACTERIZATION OF CERTAIN MARINE BACTERIA ...Bact. morphology (general), Bacterial Culture, Biology, Isolation From Nat. environ. , Marine Bacteria, Metabolism (intracellular), ...5.0784

STRUCTURAL AND FUNCTIONAL ORGANELLE INTERACTIONS ...Differentiation Mechanism, Marine Plants, Organelle & Membrane Formation, Plant Developmental Biology, Structural Functions, ...5.0689

Tissues -biological

Composition

Chemical Analysis

RADIOPASTEURIZATION OF FISHERY PRODUCTS-OPERATION AND DEVELOPMENTAL INVESTIGATIONS ...Fish - non-specific, Microbiological, Organoleptic Studies, Radiation, Shelf Life & Storage, ...6.0033

COMMERCIAL IRRADIATION OF SHELLFISH WITH A PORTABLE SHIPBOARD IRRADIATOR ...Microbiological, Organoleptic Studies, Radiation, Shelf Life & Storage, Shrimp, ...6.0025

PREPARATION OF FISH PROTEIN HYDROLYSATES ...Analysis of Foods, Fish -non-specific, Fish Protein Concentrate, Heat, Protein, ...6.0066

CLADOPHORA AS RELATED TO POLLUTION IN WESTERN LAKE ERIE ...Algal Pollutant Sources, Bioindicators, Cladophora, Lake Erie, Mapping, ...6.0170

LIPID OXIDATION AND ASSOCIATED BIOCHEMICAL CHANGES OCCURRING DURING THE PROCESSING AND STORAGE OF FISHERY PRODUCTS ...Anti-oxidants, Fats, Fish -non-specific, Food Spoilage Detection, Rancidity, ...6.0071

DEVELOPMENT OF RADIATION STERILIZED FISH ITEMS FOR ARMED FORCES FEEDING ...Anti-oxidants, Consumer Pref. & Consumption, Fish -non-specific, Military Rations, Radiation, ...6.0073

UTILIZATION AND PREPARATION OF FISH PROTEIN CONCENTRATE ...Fish & Shellfish, Fish Protein Concentrate, Nutritive Value, Organoleptic Studies, Proteins, ...6.0125

LABORATORY SCALE INVESTIGATION INTO THE FEASIBILITY OF RADIOPASTEURIZING FISH PRODUCTS ...Microbiological, Organoleptic Studies, Radiation, Shelf Life & Storage, Shellfish -non-specific, ...6.0035

FUNDAMENTAL RADIATION CHEMISTRY RESEARCH ...Antibiotics, Fish -non-specific, Packaging, Radiation, Radiochemical Analysis, ...6.0040

IDENTIFICATION OF SOCKEYE SALMON STOCKS BY BONE MINERALS ...Animal Taxonomy, Bone, Pacific Ocean-general, Salmon -coho,chinook,sockeye.., ...5.0333

CONTROL OF OXIDATIVE CHANGES IN FRESHWATER FISH ...Fish -non-specific, Freezing, Fresh Water, Organoleptic Studies, Rancidity, ...6.0045

INVESTIGATION OF FOOD PRESERVATION METHODS ...Fish -other, Food Processing -other, Food Spoilage -other, Organoleptic Studies, Physical and Chemical Change, ...6.0016

Histochemistry - Cytochem

HISTOCHEMICAL STUDIES OF MUCOSUBSTANCES IN THE MANTLE OF THE NORTHERN QUAHOG, MERCENARIA MERCENARIA ...Calcification, Clams, Derivatives, Mucopolysaccharides, Mucoproteins, ...5.0455

GAMETOGENESIS AND FERTILIZATION IN THE BLUE CRAB, CALLINECTES SAPIDUS RATHBUN, AND OTHER CRABS ...Crabs, Electron Microscopy, Reproductive System, Structural Functions, ...5.0478

A HISTOCHEMICAL STUDY OF THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Cholinesterase, Horseshoe Or King Crabs, Nervous System, Organelle-enzyme Assn, ...5.1000

THE MORPHOLOGY, HISTOCHEMISTRY, AND MODE OF SECRETION IN THE VENOM GLAND OF SEA SNAKES ...Endocrine -other, Snakes, Venom, Vertebrate Anatomy, ...5.0529

COMPARATIVE BIOCHEMICAL AND MORPHOLOGICAL CHARACTERISTICS OF MARINE FUNGI FROM SHELLFISH ...Endoparasites -other, Fungal Culture, Histology and Cytology, Marine Fungi (non-specific), Plant Taxonomy, ...5.0791

HISTOLOGICAL, HISTOCHEMICAL AND HISTOPATHOLOGICAL EFFECTS OF WATER POLLUTANTS ON MARINE ORGANISMS ...Histology and Cytology, Marine Biology (non-specific), Pollution Sources-general, Toxic Substances -non-specific, ...5.0923

BIOCHEMICAL STUDIES ON SILICEOUS SKELETAL FORMATION ...Algae- Diatoms, Cell Wall, Golgi Apparatus, Plant Developmental Biology, Silicon, ...5.0750

STRUCTURAL ANALYSIS OF CELL DIVISION ...Basic Embryology, Cell Cycle, Nucleolus, Nucleus (non-specific & Ot.), Sea Urchins & Other Echinoderm, ...5.0645

RENIN AND EURYHALINITY ...Comparative Physiology, Kidney and Urinary System, Osmoregulation, Renin, Vertebrates - non-specific, ...5.0973

Histology and Cytology

ULTRASTRUCTURAL AND AUTORADIOGRAPHIC INVESTIGATION OF CALCIFICATION IN FORAMINIFERS ...Calcification, Calcium, Cell Wall, Cell. organ. & Organoids - ot, Foraminifera, Invertebrate Culture, ...5.0788

COMPARATIVE MORPHOLOGY OF MARINE NEMATODES ...Comparative Physiology, Invertebrate Anatomy, Musculoskeletal System, Nematoda -other, ...5.0567

RETINAL RHYTHMS UNDER CONTROLLED LIGHT ...Bluefish, Darkness, Light Quantity -non-specific, Visual, Visual Organs, ...5.0282

PROTOZOOLOGY ...Animal Taxonomy, Axenic Culture, Invertebrate Nutrition, Protozoa, ...5.0443

COMPARATIVE BIOCHEMICAL AND MORPHOLOGICAL CHARACTERISTICS OF MARINE FUNGI FROM SHELLFISH ...Endoparasites -other, Fungal Culture, Histochemistry - Cytochem, Marine Fungi (non-specific), Plant Taxonomy, ...5.0791

HISTOLOGICAL, HISTOCHEMICAL AND HISTOPATHOLOGICAL EFFECTS OF WATER POLLUTANTS ON MARINE ORGANISMS ...Histochemistry - Cytochem, Marine Biology (non-specific), Pollution Sources-general, Toxic Substances - non-specific, ...5.0923

Hypertrophy - Hyperplasia

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...Dermal, Lymphocystis, Neoplasm, Yellow Perch, Darters, ...5.0292

Pathology

HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE FISHES ...Contamination - Water, Killifishs - Cyprinodon, Pollution - Effects of , Pollution Effects, ...5.0323

HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE INVERTEBRATES ...Clams, Contamination - Water, Invertebrate Pathology, Pollution - Effects of , Pollution Effects, Pollution Sources-other, ...5.0497

Transplants

DEVELOPMENTAL ANALYSIS OF FUNDULUS ...Basic Embryology, Central Nervous System, Fats, Killifishs - Cyprinodon, Phospholipids, ...5.0316

Toxic Substances

Algal Toxins

RED TIDE TOXICITY ...Biochemical Analysis, Gas Chromatography, Gymnodinium, Plant Developmental Biology, Pollution Sources-other, ...5.0780

ORGANIC CHEMICAL STUDIES ON ANIMAL AND PLANT TOXIN ...Animal Toxins, Biochemical Analysis, Medicinal Plants, Plant Alkaloids, Plant Toxins, ...6.0115

LABORATORY STUDIES OF TOXIC DINOFLAGELLATES ...Algal Culture, Gonyaulax, Gulf of Mexico, Gymnodinium, Plant Origin, ...5.0837

STUDY OF TOXIN SYNTHESIS IN PRYMNESIUM PARVUM ...Axenic Culture, Biosynthesis, Gonyaulax, Gymnodinium, Prymnesium, ...6.0124

COMPARATIVE STUDIES OF DINOFLAGELLATE TOXINS ...Algae- Dinoflagellates, Algal Culture, Cellular Physiology, Toxicology, ...6.0121

CHEMISTRY OF ALGAL TOXINS ...Aphanizomenon, Bioassays, Biochemical Analysis, Gymnodinium, Microbiological Analysis, ...5.0709

Animal Toxins

EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC ...Marine Biology (non-specific), Pacific Ocean-general, Toxic Substances -non-specific, Toxicological and Allergy, ...6.0109

CHEMISTRY AND BIOLOGY OF SOME COELENTERATE NEMATOCYSTS ...Cell. organ. & Organoids -ot, Coelenterata -other, Invertebrate Physiology, Predation, ...5.0776

PHYSALIA TOXIN AND THE ACTIVITY OF BIOLOGICAL MEMBRANES ...Active Transport, Cellular Membranes (non-spec.), Jelly Fish, Toxicology, ...6.0107

PHARMACOLOGY AND CHEMISTRY OF TOXIC MARINE ANIMALS ...Female Gametes, Sculpins, Toxicology, ...6.0104

EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC ...Pacific Ocean-general, Toxicological and Allergy, Toxicology, ...6.0110

METABOLISM OF NEUROHUMORAL TRANSMITTER SUBSTANCES IN MARINE ANIMALS ...Basic Studies, Mech of Transmission, Metabolic Inhibitors, Structural Functions, ...5.0981

ORGANIC CHEMICAL STUDIES ON ANIMAL AND PLANT TOXIN ...Algal Toxins, Biochemical Analysis, Medicinal Plants, Plant Alkaloids, Plant Toxins, ...6.0115

MODE OF ACTION OF MARINE TOXINS ...Antigen, Blood Globulins, Enzyme-substrate, Sea Urchins & Other Echinoderm, ...6.0103

Bacterial Endotoxins

STUDIES ON VIBRIO FOOD POISONING ...Bacteria, Food (epidemiology), Microbiological, Toxicological and Allergy, Vasomotor, ...6.0114

Bacterial Exotoxins

GROWTH AND TOXICOGENESIS OF C. BOTULINUM IN FISHERY PRODUCTS ...Antimetabolites -non-specific, Clostridium Botulinum, Fish -non-specific, Growth (non-specific & Ot.), Medical Studies, Microbiological, ...6.0043

Fungal Toxins

FERMENTED PROTEIN-RICH FOODS ...Fermentation, Malting, Fish -non-specific, Milk, Peanuts, Soybeans, ...6.0055

Plant Toxins

ORGANIC CHEMICAL STUDIES ON ANIMAL AND PLANT TOXIN ...Algal Toxins, Animal Toxins, Biochemical Analysis, Medicinal Plants, Plant Alkaloids, ...6.0115

Toxic Substances -non-specific

EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC ...Animal Toxins, Marine Biology (non-specific), Pacific Ocean-general, Toxicological and Allergy, ...6.0109

HISTOLOGICAL, HISTOCHEMICAL AND HISTOPATHOLOGICAL EFFECTS OF WATER POLLUTANTS ON MARINE ORGANISMS ...Histochemistry - Cytochem, Histology and Cytology, Marine Biology (non-specific), Pollution Sources-general, ...5.0923

ENVIRONMENTAL CONDITIONS AND POPULATION DYNAMICS IN SELECTED UNPOLLUTED ESTUARIAL AND COASTAL AREAS ...Aquatic Ecology, Contamination - Water, Habitat Studies, Marine Biology (non-specific), Pollution - Effects of , ...5.0922

TOXIC IMPURITIES IN MARINE PROTEIN CONCENTRATE ...Fish Protein Concentrate, Food Spoilage -other, Infection, Intoxication & Pois, Toxicological and Allergy, ...6.0009

ASPECTS OF RELATIONSHIPS BETWEEN MARINE ECOLOGY AND HUMAN HEALTH ...Environmental Ecology, Marine Biology (non-specific), Mechanism of Transmission, Public Health Ecology, ...6.0182

Toxicity Or Residue in Animals

Laboratory Animals

EXPLORATORY COLLECTION AND CARE OF FISH FOR TESTING AT TIBURON ...Bioassay , California, Fish -non-specific, San Francisco Bay, ...5.0116

TOXICANT TOLERANCE STUDIES-SCREENING OF PESTICIDES AND FISH AT TIBURON ...California, Fish -non-specific, Pesticides -non-specific, Screening Potential Pesticides, ...5.0278

TOXICANT TOLERANCE STUDIES - SCREENING OF PESTICIDES AND AQUATIC INVERTEBRATES AT TIBURON ...California, Herbicides -non-specific, Insecticides -non-specific, Screening Potential Pesticides, ...5.0906

LABORATORY BIOASSAYS ...Contamination - Water, Fish, Laboratory, Pollution - Effects of Pollution Sources-general, ...5.0882

Wildlife

Fish

PESTICIDES ...Aquatic Or Soil-aquatic Cycles, Bioassay, Persistance of Residues, Pesticides -non-specific, Pollution Effects, ...5.0881

LABORATORY BIOASSAYS ...Contamination - Water, Laboratory, Laboratory Animals, Pollution - Effects of , Pollution Sources-general, ...5.0882

RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...Insecticides -non-specific, Lake Michigan, Lake Superior, Lake Trout, Brook Trout, Pollution Effects, Salmon -coho,chinook,sockeye.., ...6.0154

FISH HOLDING AND LIFE STAGE SENSITIVITY STUDIES ...Contamination - Water, Environment Resistance, Fish -non-specific, Great Lakes-general, Maturity & Growth Stages, ...5.0276

PESTICIDE RESISTANT FISH IN NATURAL ECOSYSTEMS ...Animal Resistance -other, Endrin, Food Chains, Animal And/or Man, Pollution Effects, Rates, Doses, Concentrations, ...5.0277

Toxicity Or Residues in Humans

Residues in Foods

RADIATION PASTEURIZATION OF SHRIMP AND OYSTERS ...Iced Cooling and Storage, Organoleptic Studies, Oysters, Radiation, Shrimp, ...6.0024

Trace Analysis

Inorganic

BIOLOGICAL FRACTIONATION OF STABLE ISOTOPES ...Chemistry, Microbiological Analysis, Trace Elements, ...7.0052

Trace Elements

BIOLOGICAL FRACTIONATION OF STABLE ISOTOPES ...Chemistry, Inorganic, Microbiological Analysis, ...7.0052

PHYSIOLOGY OF LUMINESCENT SIGNAL SYSTEMS ...Bioluminescence, Photoreception, Visual Organs, ...5.0950

STUDIES IN MARINE CHEMISTRY ...Bone, Chemistry, ...7.0068

MARINE BIOLOGY PROGRAM ...Distribution, Productivity - Food Chain, Puerto Rico, Radioecology, Rare Earths, ...1.0128

CHEMICAL OCEANOGRAPHY ...Aquatic Ecology, Circulation-general, Convection, Technique Development, ...1.0134

Tracers

RADIOISOTOPIC TRACER STUDY TO INVESTIGATE THE MECHANICS OF LITTORAL TRANSPORT AROUND POINT CONCEPTION, CALIFORNIA ...Continental Shelf, Distribution, Ocean Waves - Currents, Sediment Transport-other, Xenon, ...7.0216

LIGHT IN THE SEA ...Index of Refraction, Optical, Scattering, Water Analysis-general, Water Motion, ...1.0168

DYNAMICS OF THE NITROGEN CYCLE IN THE SEA ...General Sea Water Chemistry, Nitrate, Nitrite, Nitrogen, Nitrogen Fixation, ...5.0933

OCEAN-ATMOSPHERE STUDIES WITH STABLE ISOTOPES AND DISSOLVED GASES ...Air-sea Boundary-general, Equilibrium - Chemical, Gases, Mixing, Oceanic Fronts, Particle-gas Transfer, ...**3.0005**

TRITIUM AS A TRACER FOR MIXING PROCESSES ...Currents-ocean, Mixing, Radioactivity-general, Salinity, Tritium, ...**2.0053**

DETERMINATION OF TRITIUM IN NATURAL WATERS ...Nuclear Explosions - Fallout, Radioactivity, Trace Elements, Tritium, ...**1.0083**

STUDY OF DEEP PACIFIC CIRCULATION USING SILICON-32 ...Carbon, Circulation-general, General Sea Water Chemistry, Pacific Ocean-general, Silicon, ...**2.0006**

CHEMICAL OCEANOGRAPHY ...Arctic, Circulation-general, Isotope Tracer-other, Oceanic Fronts, Water Analysis-general, ...**1.0072**

WATER MASS TRACERS ...Acoustical, Circulation-general, Currents-ocean, Oceanic Fronts, ...**2.0020**

CURRENT STUDY ON THE NEUSE RIVER AND ESTUARY ...Discharge, Dyes, Estuaries, North Carolina, Water Motion, ...**2.0037**

MEASURING PAST OCEANOGRAPHIC CONDITIONS ...Internal Structure, Paleoenvironments, Paleontology, Salinity, Temperature, ...**7.0180**

RADIOISOTOPIC SAND TRACER STUDY, POINT CONCEPTION, SANTA BARBARA COUNTY, CALIFORNIA ...California, Ocean Waves - Currents, Other Sediment Type, Sediment Transport-general, ...**7.0194**

PHYSICAL AND RADIOLOGICAL CHEMISTRY OF OCEAN SOLUTIONS ...Chemical Reactions, Octopus, Squid, Cuttlefish... , Pacific Ocean-north, Radioactive Fallout, Radioactivity-general, ...**1.0133**

RADIOISOTOPE TRACERS IN OCEANOGRAPHIC RESEARCH ...Circulation-general, Radioactivity-general, Sampling, Trace Elements, ...**2.0001**

TRACE ELEMENT EQUILIBRIUM STUDIES ...Adsorption, Chelating Agents, Ion Exchange, Material Recovery, Trace Elements, ...**1.0088**

UTILIZATION OF RADIOACTIVE TRACERS IN BEACH STUDIES ...Fluorometry, Isotope Tracer-other, ...**7.0218**

INTERACTIONS OF MARINE NUTRIENT COMPLEXES ...Iron, Marine Plants, Nutrients, Phosphorus, Phytoplankton, ...**5.0956**

Dyes

CURRENT STUDY ON THE NEUSE RIVER AND ESTUARY ...Discharge, Estuaries, North Carolina, Tracers, Water Motion, ...**2.0037**

EDDY DIFFUSION AND BACTERIAL REDUCTION IN WASTE FIELDS ...Bacterial Pollutant Sources, Diffusion, Dispersion -water, Mixing, Pollutants - Path of , Sewers, ...**6.0137**

DISPERSION PROCESSES IN ESTUARIES AND RIVERS ...Dispersion -water, Estuaries, Streams, Synthetic Hydrology, ...**2.0050**

Radioisotopes

GEOCHEMICAL STUDIES OF CONTINENTAL WATERS ...Authigenesis, Element Ratios, Geochemical Analysis, Isotope, Isotope Tracer-other, Location, Pore Fluids, Water Analysis, ...**1.0121**

Tracers-general

TURBULENT DIFFUSION STUDY ...Chesapeake Bay, Dispersion -water, Estuaries, Turbulent Flow, Water Motion, ...**2.0056**

NUTRIENT ASSIMILATION RATES - FIELD STUDIES ...Estuaries, Nitrogen, Nitrogen Cycle, Nutrients, Phosphorus, ...**5.0990**

TRACERS STUDIES IN ALASKAN HARBORS ...Estuaries, Flow Augmentation, Harbors, Industrial Wastes, Tides, ...**2.0049**

Training Grants, Fellowships

PARTIAL SUPPORT OF A PROGRAM OF EDUCATION & RESEARCH IN MARINE SEISMOLOGY AND GEOMAGNETICS ...Magnetic Studies, Seismic Studies, ...**7.0127**

SUPPORT OF TRAINING PROGRAMS IN INVERTEBRATE ZOOLOGY AND MARINE BOTANY ...Invertebrates -non-specific, Marine Biology, Marine Environments-general, Marine Plants, Meetings, ...**11.0028**

A TRAINING PROGRAM FOR GRADUATE STUDENTS IN MARINE SCIENCES AT THE FRIDAY HARBOR LABORATORIES ...Marine Biology, Marine Biology (non-specific), Washington, ...**11.0042**

YEAR-ROUND PROGRAM OF RESEARCH IN MARINE ECOLOGY ...Animal Taxonomy, Aquatic Ecology, Marine Biology (non-specific), Plant Ecology (non-specific), Plant Taxonomy, ...**5.0899**

RESEARCH TRAINING IN MARINE BIOLOGY, PALEONTOLOGY AND SYSTEMATIC ZOOLOGY ...Animal Taxonomy, Invertebrates -non-specific, Oceanography-general, Paleontology, ...**11.0003**

SUPPORT OF RESEARCH VESSEL VELERO 4 ...California, Equipment Purchase Operation, Facilities, Geology-general, Instrumentation-general, Marine Biology, ...**4.0115**

STANFORD BIOLOGICAL OCEANOGRAPHY ...Marine Biology, Phytoplankton, Primary Productivity, Productivity - Food Chain, Ships and Cruises, Zooplankton, ...**11.0005**

SUPPORT OF THE R/V EASTWARD ...Caribbean Sea, Continental Shelf, Cooperative-studies, Facilities, Marine Biology (non-specific), Ships and Cruises, ...**12.0039**

COOPERATIVE RESEARCH AND TRAINING PROGRAM IN BIOLOGICAL OCEANOGRAPHY ...Caribbean Sea, Facilities, Marine Biology (non-specific), Meetings, Ships and Cruises, ...**11.0037**

RESEARCH AND TRAINING IN MARINE BIOLOGY ...Marine Biology (non-specific), North Carolina, ...**11.0038**

INTERRELATIONSHIPS OF MARINE ORGANISMS AND SEDIMENTS ...Marine Biology (non-specific), Sediments-general, ...**5.0857**

STUDENT RESEARCH AT THE MARINE SCIENCE CENTER ...Facilities, Intertidal Areas, Invertebrate Physiology, Invertebrates -non-specific, Oregon, ...**11.0039**

RESEARCH AND GRADUATE TRAINING IN FOOD AND DRUGS FROM THE SEA, AND MARINE POLLUTION ...Antimicrobial, Carcinostatic, Chemistry, Fish Protein Concentrate, Pollution Sources-general, ...**6.0060**

APPLIED MARINE ENGINEERING PROGRAM AT SCRIPPS INSTITUTION OF OCEANOGRAPHY ...California, Engineering Studies-general, Harbors, Marine Biology, Marine Biology (non-specific), Other-design-and-construction, Scientific-service-support, Teaching and Research, ...**11.0006**

INVESTIGATE THE CAUSE OF MORTALITY OF PACIFIC OYSTERS ALONG THE CALIFORNIA COAST ...California, Environmental Ecology, Mortality Rates, Oysters, Pathology, ...**5.0360**

SHELLFISH EMBRYOLOGY AND LARVAE DEVELOPMENT STUDY ...Basic Embryology, Captive Rearing, Crustacea -non-specific, Mollusks -non-specific & Other, ...**5.0358**

Transportation Engineering

Administration & Management

RESEARCH ADVISORY SERVICES ...Freight, Loading/unloading, Scientific-service-support, Water Transportation, ...**12.0014**

Economics

Economic Analysis

MARINE TRANSPORTATION ECONOMIC ANALYSIS ...Freight, Management Science, Production & Processing, Water Transportation, ...**4.0179**

General Studies

Transportation Systems

SIMULATION MODEL FOR THE ANALYSIS OF ADVANCED MARINE SHIPPING SYSTEMS ...Simulation Theory, Water Transportation, ...**4.0063**

COMPETITIVE MERCHANT SHIP PROJECT (BULK) DRY BULK COMMODITY FORECASTS ...Consumption, Freight, Merchant-ships, ...**8.0029**

MODEL FOR PRELIMINARY EVALUATION OF TOTAL CARGO TRANSPORTATION TIME AND TRANSPORTATION COST FOR ADVANCED CARGO TRANSPORTATION SYSTEMS ...Computer Applications, Costs, Freight, Yards-docks, ...**4.0067**

Visibility

LOOK-OUT ASSIST DEVICE ...Fog-haze-mist, Navigation, Navigation Communication, Radar, Warning-systems, ...**8.0146**

Pipelines

BACKGROUND AND EXPLORATORY STUDIES OF MATERIALS HANDLING IN THE MARINE ENVIRONMENT ...Equipment, Freight, Ocean Mining, Rock Fragmentation Methods, Scientific-service-support, ...8.0258

Services

Freight

RESEARCH ADVISORY SERVICES ...Administration & Management, Loading/unloading, Scientific-service-support, Water Transportation, ...12.0014

TRANSOCEAN TUG-BARGE FEASIBILITY ...Barges-towboats, Connectors, Other-design-and-construction, ...8.0030

TRANSITIONAL CONTAINERSHIP CONCEPT ...Merchant-ships, Modification-conversion, Other-design-and-construction, ...8.0317

CATAMARAN CONTAINERSHIP FEASIBILITY ...Barges-towboats, Computer Applications, Models, Storage, ...8.0273

SURFACE EFFECT SHIP ECONOMIC OPPORTUNITY ...Flow, Origin-destination Studies, Surface Ships, ...8.0028

COMPETITVE MERCHANT SHIP (BULK) DEVELOPMENTAL PLAN ...Merchant-ships, Water Vessel, ...4.0072

COMPETITIVE MERCHAND SHIP (BULK) TECHNICAL INNOVATIONS ...Merchant-ships, Other-design-and-construction, Water Vessel, ...4.0064

COMPETITIVE MERCHANT SHIP PROJECT (BULK) DRY BULK COMMODITY FORECASTS ...Consumption, Merchant-ships, Transportation Systems, ...8.0029

DIGEST OF THE ADVANCED NUCLEAR CARGO SHIP STUDY ...Merchant-ships, Nuclear, Other-design-and-construction, ...8.0275

AN OPTIMUM LOADING SEQUENCE FOR CONTAINERSHIPS ...Computer Applications, Engineering Studies-other, Loading/unloading, Model Studies, Packing, ...8.0033

A STUDY OF A TRANSITIONAL CONTAINERSHIP CONCEPT ...Merchant-ships, Naval Architecture-general, Other-design-and-construction, ...8.0277

MARINE TRANSPORTATION ECONOMIC ANALYSIS ...Economic Analysis, Management Science, Production & Processing, Water Transportation, ...4.0179

MODEL FOR PRELIMINARY EVALUATION OF TOTAL CARGO TRANSPORTATION TIME AND TRANSPORTATION COST FOR ADVANCED CARGO TRANSPORTATION SYSTEMS ...Computer Applications, Costs, Transportation Systems, Yards-docks, ...4.0067

ANALYSIS OF INLAND CARGO CONSOLIDATION CENTERS ...Data Reduction and Analysis, Development of Models, Loading/unloading, Mathematical Models, Warehouses, ...8.0032

SUBAERIAL AND SUBAQUEOUS FLOW OF SLURRIES ...Sedimentation, ...7.0222

BACKGROUND AND EXPLORATORY STUDIES OF MATERIALS HANDLING IN THE MARINE ENVIRONMENT ...Equipment, Ocean Mining, Pipelines, Rock Fragmentation Methods, Scientific-service-support, ...8.0258

Support Services

Loading/unloading

RESEARCH ADVISORY SERVICES ...Administration & Management, Freight, Scientific-service-support, Water Transportation, ...12.0014

THE FEASIBILITY OF REDUCED CARGO GEAR INSTALLATION ONBOARD BREAK-BULK CARGO SHIPS ...Hull, Material Handling Devices, Merchant-ships, ...8.0035

AN OPTIMUM LOADING SEQUENCE FOR CONTAINERSHIPS ...Computer Applications, Engineering Studies-other, Freight, Model Studies, Packing, ...8.0033

ANALYSIS OF INLAND CARGO CONSOLIDATION CENTERS ...Data Reduction and Analysis, Development of Models, Freight, Mathematical Models, Warehouses, ...8.0032

Packing

AN OPTIMUM LOADING SEQUENCE FOR CONTAINERSHIPS ...Computer Applications, Engineering Studies-other, Freight, Loading/unloading, Model Studies, ...8.0033

Storage

CATAMARAN CONTAINERSHIP FEASIBILITY ...Barges-towboats, Computer Applications, Freight, Models, ...8.0273

Terminals

Ports & Harbors

MARINE TRANSPORTATION ANALYSIS MODEL ...Cost Analysis, Input - Output Analysis, Models, Water Vessel, ...8.0031

Warehouses

ANALYSIS OF INLAND CARGO CONSOLIDATION CENTERS ...Data Reduction and Analysis, Development of Models, Freight, Loading/unloading, Mathematical Models, ...8.0032

Traffic Engineering

Flow

SURFACE EFFECT SHIP ECONOMIC OPPORTUNITY ...Freight, Origin-destination Studies, Surface Ships, ...8.0028

Traffic Control

DUPLICATE LIMIT STANDARDS FOR SIGNAL COLORS ...Air Traffic Control-other, Colorimetry, Filter, Navigation Communication, Standards, Specifications, ...4.0096

Transportation Surveys

Origin-destination Studies

SURFACE EFFECT SHIP ECONOMIC OPPORTUNITY ...Flow, Freight, Surface Ships, ...8.0028

Vehicles

Water Vessel

COMPETITVE MERCHANT SHIP (BULK) DEVELOPMENTAL PLAN ...Freight, Merchant-ships, ...4.0072

COMPETITIVE MERCHAND SHIP (BULK) TECHNICAL INNOVATIONS ...Freight, Merchant-ships, Other-design-and-construction, ...4.0064

MARINE TRANSPORTATION ANALYSIS MODEL ...Cost Analysis, Input - Output Analysis, Models, Ports & Harbors, ...8.0031

Water Transportation

RESEARCH ADVISORY SERVICES ...Administration & Management, Freight, Loading/unloading, Scientific-service-support, ...12.0014

SIMULATION MODEL FOR THE ANALYSIS OF ADVANCED MARINE SHIPPING SYSTEMS ...Simulation Theory, Transportation Systems, ...4.0063

MARINE TRANSPORTATION ECONOMIC ANALYSIS ...Economic Analysis, Freight, Management Science, Production & Processing, ...4.0179

Travel Grants

LEARNING IN OCTOPUS ...Behavior, Learning and Retention, Octopus, Squid, Cuttlefish... , ...5.0491

SHIPBOARD WORK ABOARD THE OCEANOGRAPHER ...Microfossils, Ships and Cruises, ...11.0004

TRANSPORTATION EXPENSES FOR PARTICIPATION IN USC&GSS OCEANOGRAPHER GLOBAL EXPEDITION ...Expeditions, Oceanography-general, Ships and Cruises, ...12.0038

CETACEA OF TIERRA DEL FUEGO ...Facilities, Mammals, Survey Studies, Tierra Del Fuego, ...5.0544

Tritium

TRITIUM IN HURRICANES ...Aircraft, Heat and Radiation Transfer, Heat Exchange, Particle-gas Transfer, Tracers, Tropical Cyclones, ...3.0047

AN INVESTIGATION OF TRITIUM IN RAIN WATER ...Atmosphere Composition, Humidity, Particle-gas Transfer, Precipitation-other, Rain-other, ...1.0130

TRITIUM AS A TRACER FOR MIXING PROCESSES ...Currents-ocean, Mixing, Radioactivity-general, Salinity, Tracers, ...2.0053

DETERMINATION OF TRITIUM IN NATURAL WATERS ...Nuclear Explosions - Fallout, Radioactivity, Trace Elements, Tracers, ...1.0083

TRITIUM IN HURRICANES ...Air Pollution Sampling, Atlantic Ocean-general, Particle-gas Transfer, Sampling, Tropical Cyclones, ...3.0018

Tsunami

THEORETICAL ACOUSTIC-GRAVITY WAVE PROPAGATION ...Earthquake Location, Earthquakes, Energy Exchange Processes, Nuclear Devices, Waves, ...2.0126

TSUNAMI RUNUP EXPERIMENTS ON A SCALE MODEL OF OAHU ...Forecasting-prediction, Hawaii, Model Studies, ...2.0111

GENERATION, PROPAGATION, AND COASTAL EFFECTS OF TSUNAMIS ...Earthquakes, Harbors, Propagation, Shoreline - Coastline, Shoreline Structures, ...2.0095

THEORETICAL STUDIES OF TSUNAMI PROPAGATION ...Depth, Environmental Effects-geologic, Forecasting-prediction, Geomorphology-topography, Waves, ...2.0122

MEASUREMENT OF SURGING IN KUHIO BAY, HILO HAWAII ...Gaging, Harbors, Hawaii, Water Motion Recorders, Waves, ...2.0112

MECHANICS OF WAVE ACTION IN DEEP AND SHALLOW WATER ...Currents-longshore, Geomorphology-topography, Sand Bars, Waves, Waves-internal, ...2.0100

Tunisia

CHANGES IN SEA LEVEL IN NORTHERN TUNESIA ...Archeology, Sea Level Variations, Sedimentation, Shoreline - Coastline, ...7.0208

Turbidity Currents

ABYSSAL PLAIN SEDIMENTATION AND STRATIGRAPHY OFF OREGON ...Abyssal, Bathymetry, Coring and Dredging, Paleoclimatology, Sedimentation, ...7.0272

NATURE AND VELOCITY OF CURRENTS AND OTHER FLOWS IN SUBMARINE CANYONS ...Convection, Fans, Ocean Waves - Currents, Sedimentation, Submarine Canyons, Water Motion Recorders, ...2.0008

Turbulence - Sea Water

STUDY OF OCEANIC TURBULENCE ...Energy, Hydrodynamics, Mixing, Subsurface Environments, Water Motion, ...2.0055

EXPERIMENTAL STUDY OF THE INTERRELATIONS BETWEEN WIND-WAVE PROPERTIES ...Hydrodynamics, Mixing, Pressure, Waves, Wind-water Interaction, ...2.0123

STUDY OF LOW FREQUENCY SURFACE WAVES IN THE PACIFIC OCEAN ...Meteorological Studies, Sea Level Variations, Tides, Water Motion Recorders, Waves, ...2.0068

THERMAL WAKE STUDIES ...Physical Analysis, Thermal, Thermocline, Waves-internal, ...1.0174

SHALLOW WATER ACOUSTIC PROPAGATION STUDIES (SWAPS) ...Acoustical, Geomorphology-topography, Liquids, Subbottom, Thermal, Transmission, Water Motion, Waves, ...1.0065

Turkey

DEVELOPMENT OF A PHOTOGRAPHIC SUIT FOR STEREOPHOTOGRAMMETRIC MAPPING BY SUMBERSIBLE ...Mapping, Navigation, Photography, Sonar, Submersibles, ...4.0060

Tyramine

BIOSYNTHESIS OF 3-HYDROXYTYRAMINE IN MONOSTROMA FUSCUM ...Biosynthesis, Chlorophyceae (non-specif.&ot), Dopa Decarboxylase, Marine Plants, Tyrosinase, ...5.0720

Underwater Ordnance

Ordnance

FUNDAMENTAL PROBLEMS IN HYDRODYNAMICS ...Convection, Hydrodynamics, Survey Studies, Waves, Waves-internal, ...2.0102

OCEAN PRESSURE RESEARCH ...Military Aspects, Pressure, Underwater Warfare, ...1.0173

SUBMARINE MEDICINE ...Life-support-system, Naval Personnel, Occupational Hazards, Safety, ...8.0018

Sound Gear

DIGITAL OUTPUT SURVEY DEPTH SOUNDING ...Bathymetry, Coding, Digital Computer Applications, Readout Systems, Sonar, ...8.0123

DEVELOPMENT OF AN ADVANCED MISSILE IMPACT LOCATING SYSTEM FOR THE EASTERN TEST RANGE ...Acoustical, Area, Atlantic Ocean-north, Missile & Rockets, Navigation, ...8.0048

MICROACOUSTICS ...Acoustical, Reflection, Scattering, Water Tunnels Tables, ...1.0043

SONIC UNDERWATER NAVIGATION FOR SHIPS ...Equipment, Instrumentation-other, Navigation, Ranging, Sonar, ...4.0100

Underwater Warfare

OCEAN PRESSURE RESEARCH ...Military Aspects, Ordnance, Pressure, ...1.0173

United States-general

ISLAND STUDY ...Conservation-general, Islands, Land Economics, Recreation Sites, Types of Resources, ...9.0005

Upper Atmosphere Physics

Atmospheric Circulation

Energy Exchange Processes

THEORETICAL ACOUSTIC-GRAVITY WAVE PROPAGATION ...Earthquake Location, Earthquakes, Nuclear Devices, Waves, ...2.0126

WEATHER PROGRAM - STATION T-3 ...Arctic Ocean, Drift Stations, Heat Budget, Patterns, Physical Climatology, Weather Forecasting, ...3.0060

General Movement

THREE-DIMENSIONAL GLOBAL CLIMATOLOGY ...Air Motion-general, Applied Climatology, Patterns, Spectral Analysis, Tables, Compilations, Catalogs, ...3.0067

RELATION OF SATELLITE DATA TO LARGE SCALE ATMOSPHERIC CIRCULATION AND ENERGETICS ...Anticyclones-cyclones, Patterns, Radiation-general, Satellites, Weather Charts-maps, ...4.0143

Jet Streams

LARGE-SCALE INERTIAL OCEAN-ATMOSPHERE RELATIONSHIPS ...Air-sea Boundary-general, Greenland Sea, Patterns, Sea Ice, Sea of Okhotsk, Weather Forecasting, ...3.0024

Mass Transport

EQUATORIAL CIRCULATIONS IN THE STRATOSPHERE ...Atmospheric Divisions, Ocean-lakes, Patterns, Tropic, ...3.0066

Waves

THE PROPAGATION OF ACOUSTIC WAVES IN THE STRATIFID ATMOSPHERES ...Acoustics, Temperature, Transmission, Wind-general, ...1.0059

THEORETICAL ACOUSTIC-GRAVITY WAVE PROPAGATION ...Earthquake Location, Earthquakes, Energy Exchange Processes, Nuclear Devices, ...2.0126

Atmospheric Phenomena

Attenuation, Absorption

VLF TIMING STUDIES ...Electromagnetic Transmission, Navigation, Standards, Specifications, Time Measurements, Very Low Frequency, ...4.0092

Aurora

EARTH CURRENT STUDIES ...Earth-telluric Current, Magnetic Studies, ...4.0085

Noise

NOISE LIMITATION UPON AEROMAGNETIC MEASUREMENTS ...Airborne Probing, Geomagnetic Field, Magnetic Sensor, Magnetometers, Surface Environments, ...8.0097

MAGNETIC AND GRAVITY PREDICTION ...Geomagnetic Field, Magnetic Sensor, Magnetic Studies, ...4.0044

Atmospheric Structure

Atmospheric Divisions

EQUATORIAL CIRCULATIONS IN THE STRATOSPHERE ...Mass Transport, Ocean-lakes, Patterns, Tropic, ...3.0066

GEOMAGNETIC STUDIES ...Airborne Probing, Earth-telluric Current, Fluctuations, ...7.0134

ION CLOUDS IN THE UPPER ATMOSPHERE ...Chemical Releases, Clouds-precipitation, ...3.0089

Magnetic Effects

Geomagnetic Field

NOISE LIMITATION UPON AEROMAGNETIC MEASUREMENTS ...Airborne Probing, Magnetic Sensor, Magnetometers, Noise, Surface Environments, ...8.0097

MAGNETIC AND GRAVITY PREDICTION ...Magnetic Sensor, Magnetic Studies, Noise, ...4.0044

Radiation

Albedo

AIR-SEA EXCHANGE ...Heat and Radiation Transfer, Infrared Radiation, Massachusetts, Temperature, Towers, ...3.0026

Sonic Effects

Acoustics

THE PROPAGATION OF ACOUSTIC WAVES IN THE STRATIFID ATMOSPHERES ...Temperature, Transmission, Waves, Wind-general, ...1.0059

Techniques

Airborne Probing

GEOMAGNETIC STUDIES ...Atmospheric Divisions, Earth-telluric Current, Fluctuations, ...7.0134

NOISE LIMITATION UPON AEROMAGNETIC MEASUREMENTS ...Geomagnetic Field, Magnetic Sensor, Magnetometers, Noise, Surface Environments, ...8.0097

SATELLITE TIME DISSEMINATION ...Communication & Navigation, Doppler, Navigation, Signal Generators, Standards, Specifications, Time Measurements, ...4.0091

Chemical Releases

ION CLOUDS IN THE UPPER ATMOSPHERE ...Atmospheric Divisions, Clouds-precipitation, ...3.0089

Magnetic Sensor

NOISE LIMITATION UPON AEROMAGNETIC MEASUREMENTS ...Airborne Probing, Geomagnetic Field, Magnetometers, Noise, Surface Environments, ...8.0097

MAGNETIC AND GRAVITY PREDICTION ...Geomagnetic Field, Magnetic Studies, Noise, ...4.0044

Radiation Detection

AIRBORNE SEA SURFACE MEASUREMENTS IN THE EQUATORIAL PACIFIC ...Atolls, Humidity, Infrared Radiation, Mapping, Oceanic Fronts, Temperature, ...1.0190

MICROWAVE RADIOMETER DEVELOPMENT ...Instrumental Services, Microwave Radiation, Microwave Techniques, Radiation-terrestrial, Wave Form, ...8.0056

Uranium

DEPOSITION RATES BY THE PROTACTINIUM METHOD ...Chemical, Distribution, Element Ratios, Manganese, Sedimentary Petrogenesis, Thermal, Thorium, ...7.0270

URANIUM GEOCHEMISTRY IN (MODERN) CARBONATES USING THE FISSION TRACK METHOD ...Biogeochemical Process, Carbonates-general, Chemistry, Diagenesis, Organism Sampling Devices, ...7.0076

Urban Research

Beautification

BACTERIOLOGICAL AND ESTHETIC OF PLEASURE BOAT WASTE DISCHARGE ON SMALL HARBORS ...Bacterial Pollutant Sources, Harbors, Marinas, Ship Wastes, Water Analysis, ...6.0191

Services

Recreation

HAWAII STATE COMPREHENSIVE OUTDOOR RECREATION PLAN ...Hawaii, Inventories, Methods, Projected Demand, Survey, User Characteristics, ...9.0009

Urine

RENAL SALT EXCRETION IN MARINE BIRDS ...Kidney and Urinary System, Osmoregulation, Shorebirds-gulls,terns,skimmer, ...5.0562

Urogenital System

Kidney

SUBCELLULAR REACTION TO INJURY IN THE KIDNEY ...Cell Injury and Autolysis, Cellular Membranes (non-spec.), Electron Microscopy, Structural Functions, Toads, ...5.0297

Use of Impaired Water

A UNIFIED APPROACH TO WATER, FOOD AND POWER IN A COASTAL DESERT COMMUNITY ...Arid and Desert, Desalination, Deserts, Diesel, Distilling Units, Electric Power Plants, Greenhouse, ...7.0002

Vertebrate Anatomy

COMPARATIVE STUDY OF NITROGEN SECRETION IN FISHES ...Comparative Physiology, Fish, Metabolism, Nitrogen, ...5.1022

VISUAL CAPACITIES IN TELEOST FISHES ...Behavior, Behavioral Ecology, Fish -other, Vision, Visual Organs, ...5.0290

SYSTEMATICS AND DISTRIBUTION OF WORMFISHES (MICRODESMIDAE) ...Animal Taxonomy, Bone, Collections, Fish -other, Vertical Distribution, ...5.0115

MONOGRAPH OF THE FISHES OF THE ORDER PLECTOGNATHI ...Animal Taxonomy, Bone, Comparative Anatomy, Fish -other, Pubilications -other, ...5.0146

PHYLOGENETIC SIGNIFICANCE OF SOUND-PRODUCING MECHANISMS OF OPHIDIOID AND RELATED FISHES ...Comparative Anatomy, Fish -other, Sound Production, ...5.0268

AUDITORY CAPACITIES OF TELEOST FISHES ...Audition, Auditory, Behavior, Fish -other, ...5.0291

ANATOMICAL INVESTIGATIONS OF THE LOBODONTINAE ...Collections, Ross Sea, Seals, ...5.0614

BLOOD CHEMISTRY OF FISHES ...Blood Plasma and Serum, Bone, Sharks, Vertical Distribution, ...5.0239

GERMFREE FISH ...Captive Rearing, Fish -other, Germ Free Animal, Immunology, Infectious Conditions and Dis, ...5.0236

VENOMOUS FISHES AND SEA SNAKES OF SOUTHEAST ASIA ...Behavior, Fish -non-specific, Snakes, Southeast Asia, Venom, ...6.0101

THE MORPHOLOGY, HISTOCHEMISTRY, AND MODE OF SECRETION IN THE VENOM GLAND OF SEA SNAKES ...Endocrine -other, Histochemistry - Cytochem, Snakes, Venom, ...5.0529

SYSTEMATICS AND BIOLOGY OF EPIPELAGIC AND BATHYPELAGIC FISHES ...Animal Taxonomy, Atlantic Ocean-north, Fish -other, Indian Ocean-general, Vertical Distribution, ...5.0049

OSTEOLOGY AND EVOLUTION OF ISOSPONDYLOUS AND OSTARIOPHYSAN FISHES ...Bone, Fish -other, Organic Evolution, ...5.0053

BIOLOGY, MORPHOLOGY, AND EVOLUTION OF THE DISK-FISHES OR SHARKSUCKERS ...Animal Taxonomy, Ethological, Fish -other, Host Specificity, ...5.0250

DEVELOPMENTAL MORPHOLOGY OF COREGONIDS ...Aquatic Ecology, Bonneville Cisco, Cisco, Lake Herring, Developmental Physiology, Great Lakes-general, ...5.0274

INVESTIGATION OF THE BIOLOGY AND POPULATION STRUCTURE OF GULF MENHADEN ...Alewife,menhaden,shad,herring, Bone, Gulf of Mexico, Handbooks, Population Dynamics, ...5.0128

TAGGING ...Alewife,menhaden,shad,herring, Migration, Population Dynamics, Tags, Telemetry, ...5.0127

THE EFFECTS OF RADIATION ON THE MORPHOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Cooperative-studies, Fish -other, Radiation Sensitivity-, Vertebrates Excl. man, ...5.0295

ADMINISTRATION OF WHALING ACT, PROTECTED AND NON-COMMERCIAL WHALES ...Censusing, Growth Rate, Mammals, Migration, Reproduction Studies (general), ...5.0669

FUR SEAL RESEARCH, ANATOMY-BEHAVIOR-MORTALITY ...Behavior, Hair, Mortality Rates, Nutrition -other, Seals, ...5.0672

STUDIES ON OPHIDIOID FISHES ...Abyssal, Animal Taxonomy, Benthic Fauna, Fish -other, Vertical Distribution, ...5.0054

Vertebrate Anatomy

SYSTEMATIC STUDIES ON THE FAMILY SCOMBRIDAE ...Animal Taxonomy, Indian Ocean-general, Nomenclature, Classification, Tuna, Mackerel, Albacore... , ...5.0056

SYSTEMATIC STUDIES OF FISHES ...Animal Taxonomy, Developmental Physiology, Fish -non-specific, Life History Studies, ...5.0059

A REVISION OF THE CAT SHARKS, SCYLIORHINIDAE ...Animal Taxonomy, Nomenclature, Classification, Sharks, ...5.0058

STRUCTURE AND FUNCTION OF EYES ...Visual Organs, ...5.0379

PHOTOBIOLOGY OF MARINE ANIMALS ...Bioluminescence, Fish -non-specific, Visual, Visual Organs, ...5.0327

Vertebrate Nutrition

Diet Or Ration Components

Diet Or Ration -other

NUTRITION OF SALMONID FISHES ...Captive Rearing, in Vivo--see Also Feed Rations, Purified Diets, Salmon & Trout - Non-specific, ...5.0304

Energy

PHYSIOLOGY OF MARINE ORGANISMS ...Environmental Physiology, Fish -non-specific, Food Supply, ...5.0939

Fats - Lipids

THE COMPOSITION, NUTRITIVE VALUE AND QUALITY OF FISHERY PRODUCTS WITH SPECIAL EMPHASIS ON LIPID AND ITS INTERACTION ...Anti-oxidants, Fats, Fish - non-specific, Radiation, Unsaturated Fats, ...6.0076

Proteins and Amino Acids

UTILIZATION OF LATENT MARINE RESOURCES AND WASTE PRODUCTS ...Fish -other, Fish Meals, Fish Protein Concentrate, Proteins, Salmon & Trout - Non-specific, ...6.0068

Digestive System - Dig&absorb

Biological

ACCUMULATION OF RADIONUCLIDES BY VERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Contamination - Water, Estuaries, Radioactivity-general, ...5.0293

Nutrition -other

NUTRITION AND PHYSIOLOGY OF MARINE FISH IN CONTROLLED GNOTOBIOTIC ENVIRONMENTS ...Aquaria, Environmental Physiology, Fish -non-specific, Germ Free Animal, ...5.0317

THE ROLE OF COPROPHAGY IN MARINE FOOD CHAINS ...Feces, Invertebrate Nutrition, Productivity - Food Chain, ...5.0963

FUR SEAL RESEARCH, ANATOMY-BEHAVIOR-MORTALITY ...Behavior, Hair, Mortality Rates, Seals, Vertebrate Anatomy, ...5.0672

Vertebrate Pathology

INFECTIONS IN MARINE MAMMALS USED AS LABORATORY ANIMALS ...Detection, Infectious Conditions and Dis, Mammals, ...5.0549

OCCURRENCE OF THE PROTOZOAN PARASITE CERATOMYXA IN ADULT PACIFIC SALMON AND STEELHEAD TROUT ...Infectious Conditions and Dis, Pathology, Protozoa, Protozoa -other, Rainbow Trout, Steelhead Trout, ...5.0308

Neoplasm

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...Dermal, Hypertrophy - Hyperplasia, Lymphocystis, Yellow Perch, Darters, ...5.0292

Vetebrate Physiology

Age

SAMPLING OF GROUNDFISH STOCKS ...Bone, Codfishes, Hake, Proprioceptors, Righteye Flounders, Size, ...5.0160

COLLECTION OF MATERIALS AND DATA FOR AGE-GROWTH ANALYSIS ...Commercial Fishing, Fish -other, Growth Rate, ...5.0330

ANALYSIS OF SALMONID SCALES ...Animal Taxonomy, Columbia River, Growth Rate, Rainbow Trout, Steelhead Trout, Salmon -coho,chinook,sockeye.., Scales, ...5.0315

AGE DETERMINATION OF LARGE ATLANTIC SHARKS ...Atlantic Ocean-north, Growth Rate, ...5.1028

BIOSTATISTICS OF HERRING ...Alewife,menhaden,shad,herring, Atlantic Ocean-north, Environmental Ecology, Growth Rate, Population Dynamics, Proprioceptors, ...5.0099

ADMINISTRATION OF WHALING ACT - DEVELOPMENT OF RESEARCH TOOLS ...Management -other, Mark, Tag Or Capture -other, ...5.0670

Behavior

SIMULATED WEIGHTLESSNESS IN FISH ...Cardiovascular System, Fish -non-specific, Gravitational Fields, Gravity, Proprioceptors, ...5.0275

FACTORS AFFECTING THE BEHAVIOR OF SHARKS ...Sensory Organs, Sharks, ...5.0262

SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES ...Environmental Physiology, Fish -non-specific, Migration, Orientation, Sensory Organs, ...5.0338

VISUAL CAPACITIES IN TELEOST FISHES ...Behavioral Ecology, Fish -other, Vertebrate Anatomy, Vision, Visual Organs, ...5.0290

COMPARATIVE BEHAVIOR OF HATCHERY-REARED AND WILD SALMONIDS ...Atlantic Salmon, Sebago Salmon, Captive Rearing, Environmental Physiology, Lake Trout, Brook Trout, ...5.0264

RENEWAL RESEARCH PROPOSAL FOR HEARING AND ALLIED SENSES IN FISHES ...Auditory, Fish -non-specific, Sound Production, ...5.0254

ACOUSTICO-LATERALS FUNCTION IN FISH ORIENTATION AND COMMUNICATION ...Auditory, Fish -non-specific, Orientation, Sensory Organs, Signal Detection, ...5.0289

MOTIVATIONAL ANALYSIS OF COURTSHIP BEHAVIOR ...Aggression, Social Behavior, Tilapia, Cichlids, ...5.0231

AUDITORY CAPACITIES OF TELEOST FISHES ...Audition, Auditory, Fish -other, Vertebrate Anatomy, ...5.0291

SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES ...Migration, Olfactory, Salmon & Trout - Non-specific, Visual Organs, ...5.0339

EXPERIMENTAL STUDIES OF BEHAVIOR IN A CICHLID FISH ...Parental Care, Sex, Size, Tilapia, Cichlids, ...5.0232

MECHANISMS OF HOMING AND ORIENTATION OF SALMO CLARKI IN YELLOWSTONE LAKE AND ITS TRIBUTARIES ...Aquatic Ecology, Biological Rhythms, Cutthroat Trout, Wyoming, ...5.0279

THE EVOLUTION AND CAUSATION OF SOCIAL BEHAVIOR IN ANABANTOID FISHES ...Ethological, Fish -other, Reproduction Studies (general), Social Behavior, ...5.0300

SCHOOLING BEHAVIOR IN FISHES ...Fish -non-specific, Sensory Organs, Social Behavior, Visual Organs, ...5.0125

COMPARATIVE ETHOLOGY OF FISHES OF THE GENUS MACROPODUS ...Aggression, Fish -other, Social Behavior, ...5.0266

SENSORY BASIS OF NAVIGATION IN HOMING PIGEONS ...Biological Rhythms, Environmental Physiology, Locomotion - animal, Mark, Tag Or Capture -other, Pigeon, ...4.0108

EXPERIMENTAL ANALYSIS OF HEARING AND ACOUSTIC ORIENTATION IN SHARKS ...Auditory, Shark Repellents, Sharks, ...5.0235

VENOMOUS FISHES AND SEA SNAKES OF SOUTHEAST ASIA ...Fish -non-specific, Snakes, Southeast Asia, Venom, Vertebrate Anatomy, ...6.0101

BREEDING AND MATERNAL BEHAVIOR AMONG THE STELLER SEA LION ...Developmental Physiology, Parturition, Seals, Spawning & Nesting Sites, ...5.0524

TEMPERATURE TOLERANCE OF MARINE ANIMALS THROUGH BEHAVORIAL RESPONSES ...Environment Resistance, Mortality Rates, Thermal, Water Temperature-non-specific, ...5.0118

THERMAL PREFERENCES OF MARINE FISHES AND INVERTEBRATES ...Fish -non-specific, Invertebrates -non-specific, Thermal, Water Temperature-non-specific, ...5.0209

EFFECTS OF HOT WATER MASSES ON MARINE FISHES ...Atlantic Ocean-north, Fish -non-specific, High Temp. -85f Or Above, Oceanic Fronts, Thermal, ...5.0210

RELATION OF TEMPERATURE TO RHYTHMIC BEHAVIOR ...Biological Rhythms, Bluefish, Environmental Physiology, Locomotion -animal, Low Temp. -but Above 32f, ...5.0284

FUR SEAL RESEARCH, ANATOMY-BEHAVIOR-MORTALITY ...Hair, Mortality Rates, Nutrition -other, Seals, Vertebrate Anatomy, ...5.0672

PHYSIOLOGY AND BEHAVIOR ...Chemical Measurements - water, Environmental Physiology, Lake Michigan, Physical Measurements -water, Productivity - Food Chain, ...5.0904

BEHAVIOR OF LARVAL FISHES ...Captive Rearing, Commercial Fishing, Environmental Physiology, Fish -non-specific, Maturity & Growth Stages, ...5.0062

REPRODUCTION AND FECUNDITY OF TUNAS ...Biological Rhythms, Female Gametes, Fertility, Tuna, Mackerel, Albacore... , ...4.0159

ESTABLISHMENT AND PERPETUATION OF STOCKS OF EXPERIMENTAL FISH ...Environmental Ecology, Environmental Physiology, Fish -non-specific, Great Lakes-general, Life History Studies, ...5.0109

FISH BEHAVIOR AND PHYSIOLOGY ...Engineering Structures-general, Environmental Physiology, Migration, Salmon & Trout - Non-specific, Thermal Pollution, ...5.0331

INVESTIGATE PHYSIOLOGY OF TUNAS ...Blood -other, Environmental Physiology, Muscle, Olfactory, Tuna, Mackerel, Albacore... , ...5.0259

FEEDING BEHAVIOR ...Alewife,menhaden,shad,herring, Anchovies, Environmental Physiology, Food Supply, Sensory Organs, ...5.0040

BEHAVIOR IN EMBRYOS AS IT RELATES TO ENCEPHALIZATION ...Basic Embryology, Bullheads, Central Nervous System, Developmental Physiology, Visual Organs, ...5.0270

Sound Production

COMMUNICATIONS STUDIES ON TURSIOPS TRUNCATUS AND OTHER DELPHINIDS ...Central Nervous System, Linguistics, Mammals, Neuristors Neurol Nets, ...5.0587

PERCEPTUAL, VOCAL, AND ECHO-RANGING BEHAVIOR OF SEALS AND SEA LIONS ...Auditory, Echolocation, Seals, Visual Organs, ...5.0547

BIOLOGICAL ASPECTS OF MIDWATER SOUND SCATTERING ...Atlantic Ocean-north, Bioluminescence, Fish -non-specific, Range Or Territorial Distr. , Scattering, Vertical Distribution, ...1.0054

RENEWAL RESEARCH PROPOSAL FOR HEARING AND ALLIED SENSES IN FISHES ...Auditory, Behavior, Fish -non-specific, ...5.0254

PHYLOGENETIC SIGNIFICANCE OF SOUND-PRODUCING MECHANISMS OF OPHIDIOID AND RELATED FISHES ...Comparative Anatomy, Fish -other, Vertebrate Anatomy, ...5.0268

OPERATION OF R/V TRIDENT ...Geomorphology-topography, Phytoplankton, Sea Floor Spreading, Ships and Cruises, Subbottom, Vertical Distribution, ...12.0045

ACOUSTIC RECORDING OF MARINE MAMMALS OF NOVA SCOTIA AND NEWFOUNDLAND ...Atlantic Ocean-north, Canada, Mammals, Seals, Tape Recording, Audio, ...5.0625

BEHAVIORAL STUDIES OF CETACEANS ...Behavioral Ecology, Locomotion -animal, Mammals, ...5.0596

BEHAVIOR AND SONIC ACTIVITY OF FISHES ...Behavioral Ecology, Environmental Physiology, Fish -other, Sonar, ...1.0047

DETERMINANTS AND CONTROL OF UNDERWATER VOCALIZATIONS IN THE CALIFORNIA SEA LION ...Acoustical, Mammals, Seals, ...1.0003

WHISTLE CONTOURS IN ODONTOCETE CETACEANS ...Behavioral Ecology, Mammals, Social Behavior, ...5.0538

BIOLOGICAL SOUND ...Behavior, ...1.0064

BELUGA WHALES ...Acoustical, Behavioral Ecology, Life History Studies, Mammals, Tape Recording, Audio, ...5.0527

BIOLOGICAL OCEANOGRAPHY ...Acoustical, Atlantic Ocean-north, Marine Biology, Submersibles, ...1.0022

GLOBAL VOLUME REVERBERATION LIMITATION STUDIES ...Acoustical, Atlantic Ocean-north, Reverberation, Scattering, ...1.0037

BIOLOGICAL FALSE TARGETS AND RELATED ACOUSTIC CHARACTERISTICS ...Animal Taxonomy, Behavioral Ecology, Fish -non-specific, ...1.0041

AMBIENT SEA NOISE ...Acoustical, Buoys, Noise, Sampling, ...1.0013

DIURNAL-NOCTURNAL ACTIVITY OF THE QUEENFISH, SERIPHUS POLITUS ...Aquatic Ecology, Behavioral Ecology, Biological Rhythms, Drums, Fish -other, Other, ...5.0230

ECHO RANGING SIGNALS ...Captive Rearing, Echolocation, Mark, Tag Or Capture -other, Seals, Sonar, ...5.0546

STUDIES OF SOUND PRODUCTION ...Echolocation, Mammals, ...5.0545

ACOUSTICAL COMMUNICATION IN AQUATIC ORGANISMS ...Auditory, Biological Rhythms, Central Nervous System, Orientation, ...5.0318

Biological Rhythms

EXPERIMENTAL MANIPULATION OF MECHANICAL AND PHYSIOLOGICAL RHYTHMS - A DUAL APPROACH TO THE BIOLOGICAL CLOCK PROBLEM ...Acetabularia, Behavioral Ecology, Crabs, Perching Birds - Songbirds, ...5.1002

MECHANISMS OF HOMING AND ORIENTATION OF SALMO CLARKI IN YELLOWSTONE LAKE AND ITS TRIBUTARIES ...Aquatic Ecology, Behavior, Cutthroat Trout, Wyoming, ...5.0279

SENSORY BASIS OF NAVIGATION IN HOMING PIGEONS ...Behavior, Environmental Physiology, Locomotion -animal, Mark, Tag Or Capture -other, Pigeon, ...4.0108

DISTANT GOAL ORIENTATION ...Birds -non-specific, Locomotion -animal, Magnetic Impulses, Mark, Tag Or Capture -other, Orientation, ...4.0109

ORIENTATION CUES AND PATTERNS OF LONG-DISTANCE TRAVEL OF MARINE TURTLES ...Environmental Physiology, Migration, Orientation, Turtles, Terrapins, Tortoises, ...4.0102

COPPER RIVER SOCKEYE SALMON INVESTIGATIONS ...Alaska, Aquatic Ecology, Migration, Population Dynamics, Salmon -coho,chinook,sockeye.., Stocking of Fish & Shellfish, ...5.0025

SURVEYS OF SPAWNING SALMON ...Censusing, Number Or Density, Oregon, Salmon & Trout - Non-specific, Streams, ...5.0142

MOVEMENTS OF SEABIRDS IN THE HUMBOLDT CURRENT ...Aves -other, Humboldt Or Peru Current, Population Dynamics, Temporal Distribution, ...5.0583

RELATION OF TEMPERATURE TO RHYTHMIC BEHAVIOR ...Behavior, Bluefish, Environmental Physiology, Locomotion -animal, Low Temp. -but Above 32f, ...5.0284

DIURNAL-NOCTURNAL ACTIVITY OF THE QUEENFISH, SERIPHUS POLITUS ...Aquatic Ecology, Behavioral Ecology, Drums, Fish -other, Other, Sound Production, ...5.0230

INFLUENCE OF UNLIMITED FOOD SUPPLY ON RHYTHMIC ACTIVITY OF BLUEFISH ...Bluefish, Food Supply, Predation, ...5.0122

RHYTHMIC ACTIVITY OF BLUEFISH IN RELATION TO NORMAL LIGHT REGIME ...Bluefish, Environmental Physiology, Locomotion -animal, Photoperiod, ...5.0285

RHYTHMIC ACTIVITY OF BLUEFISH UNDER EXPERIMENTALLY VARIED LIGHT REGIMES ...Adaptation, Bluefish, Environmental Physiology, Photoperiod, Water Light Quality & Quantity, ...5.0286

REPRODUCTION AND FECUNDITY OF TUNAS ...Behavior, Female Gametes, Fertility, Tuna, Mackerel, Albacore... , ...4.0159

FISH POPULATION PARAMETERS ...Age, Life History Studies, Population Dynamics, Size, ...5.0039

ACOUSTICAL COMMUNICATION IN AQUATIC ORGANISMS ...Auditory, Central Nervous System, Orientation, Sound Production, ...5.0318

Blood-lymph-re-system

Blood -other

INVESTIGATE PHYSIOLOGY OF TUNAS ...Behavior, Environmental Physiology, Muscle, Olfactory, Tuna, Mackerel, Albacore... , ...5.0259

THE PHYSIOLOGY OF TUNA AND OTHER PELAGIC FISH ...Environmental Physiology, Sharks, Thermonegulation, Tuna, Mackerel, Albacore... , ...5.0272

Blood Cells

MECHANICAL PROPERTIES OF MAMMALIAN CELLS ...Cellular Membranes (non-spec.), Flow Metering Techniques, Suspension Culture, Time-lapse Photography, ...5.0992

CYTOTAXONOMIC STUDIES OF TELEOST FISHES ...Abyssal, Animal Taxonomy, Minnows, Sets of Chromosomes, ...5.0242

BLOOD TYPES AS INDICATORS OF BLUEFISH RACES ...Blood Plasma and Serum, Blood Typing Studies, Bluefish, Immunology, Polymorphism, ...5.0319

Vetebrate Physiology

HEMATOLOGICAL CHANGES IN F. HETEROCLITUS UPON EXPOSURE TO TOXIC METALS ...Blood Plasma and Serum, Cadmium, Killifishs - Cyprinodon, Lead, Toxins -other, ...5.0325

FUNCTION OF THE INTERRENAL GLAND IN TELEOST FISHES ...Kidney and Urinary System, Osmoregulation, Pituitary, Tilapia, Cichlids, Water Salinity, ...5.0233

Blood Typing Studies

BLOOD TYPES AS INDICATORS OF BLUEFISH RACES ...Blood Cells, Blood Plasma and Serum, Bluefish, Immunology, Polymorphism, ...5.0319

BLOOD TYPES AS INDICATORS OF WHITE MARLIN RACES ...Blood Plasma and Serum, Marlin, Billfishes, Sailfish.., Polymorphism, Statistics-general, ...5.0321

RACIAL STUDIES OF HERRING ...Alewife,menhaden,shad,herring, Animal Taxonomy, Atlantic Ocean-north, Biochemical Analysis, Management -other, ...5.0265

INVESTIGATE TUNA SUBPOPULATIONS THROUGH THE USE OF BLOOD GROUPS AND INHERITED PROTEINS ...Blood Proteins -non-specific, Pacific Ocean-general, Population Dynamics, Tuna, Mackerel, Albacore... , ...5.0076

PROVIDE FOR ACTIVITIES OF TUNA BLOOD GROUP CENTER ...Blood Plasma and Serum, Hawaii, Immunology Methods, Tuna, Mackerel, Albacore... , ...5.0258

DEVELOP TECHNIQUES FOR CAPTURING JUVENILE TUNAS ...Nets, Population Dynamics, Tuna, Mackerel, Albacore... , Vertical Distribution, ...5.0078

Hormone

STUDIES OF FISH ENDOCRINOLOGY ...Environmental Physiology, Fresh Water, Killifishs - Cyprinodon, Testes, Thyroid, ...5.0246

Protein

CHEMICAL RESPONSES BY MARINE ORGANISMS TO STRESS ...Environmental Changes, Environmental Ecology, Environmental Physiology, Salinity, Thermal, ...5.1026

Cardiovascular System

SIMULATED WEIGHTLESSNESS IN FISH ...Behavior, Fish -non-specific, Gravitational Fields, Gravity, Proprioceptors, ...5.0275

PHYSIOLOGICAL STUDIES IN THE BOTTLENOSE DOLPHIN TURSIOPS TRUNCATUS ...Adaptation, Central Nervous System, Mammals, ...5.0588

CARDIOVASCULAR ADJUSTMENT TO DIVING ASPHYXIA ...Locomotion -animal, Medical Studies, Regional Blood Flow & Volume, Seals, ...5.0552

PHYSIOLOGICAL STUDIES ON FISHES LACKING HEMOGLOBIN ...Adaptation, Fish, Fish -other, Hemoglobin, Metabolism, Polar, ...5.0241

MARINE PHYSIOLOGY ...Fish, Osmoregulation, Thermonegulation, Water Pressure, ...5.0947

CIRCULATORY REACTIONS TO ASPHYXIA ...Effects on Cardiovasc. system, Mammals, Veterinary Science, ...5.0553

CARDIOVASCULAR ADJUSTMENTS IN DIVING MAMMALS ...Adaptation, Effects on Cardiovasc. system, Locomotion -animal, Mammals, ...5.0674

CARDIOVASCULAR STUDIES ON DIVING MAMMALS ...Adaptation, Basic Hemodynamics, Control and Regulation, Heart, Locomotion -animal, Seals, ...5.0639

Comparative Physiology

COMPARATIVE PHYSIOLOGY OF RESPIRATORY MECHANICS IN MAMMALS ...Mammals, ...5.0612

CHEMISTRY AND FUNCTION OF BRAIN PLASMALOGENS ...Chem and Metab, Molec. struct. (gen. & Other), Phospholipids, Plasmalogen, ...5.1003

THE CETACEAN BRAIN - A COMPARATIVE STUDY ...Central Nervous System, Mammals, Structure-cell-tiss, ...5.0641

Digestive System

Other

DIURNAL-NOCTURNAL ACTIVITY OF THE QUEENFISH, SERIPHUS POLITUS ...Aquatic Ecology, Behavioral Ecology, Biological Rhythms, Drums, Fish -other, Sound Production, ...5.0230

Endocrine System

Endocrine -other

THE MORPHOLOGY, HISTOCHEMISTRY, AND MODE OF SECRETION IN THE VENOM GLAND OF SEA SNAKES ...Histochemistry - Cytochem, Snakes, Venom, Vertebrate Anatomy, ...5.0529

Pituitary

ENDOCRINE REGULATED PROCESSES IN TELEOST FISHES ...Comparative Physiology, Environment Resistance, Fish -other, Hypophysectomy, Osmoregulation, ...5.0288

FUNCTION OF THE INTERRENAL GLAND IN TELEOST FISHES ...Blood Cells, Kidney and Urinary System, Osmoregulation, Tilapia, Cichlids, Water Salinity, ...5.0233

PHYSIOLOGY AND ASSAY OF PROLACTIN IN FISH ...Bioassays, Biochemical, Gambusia, Molly, Immunology, Luteotrophic Hormone, ...5.0329

Thyroid

STUDIES OF FISH ENDOCRINOLOGY ...Environmental Physiology, Fresh Water, Hormone, Killifishs - Cyprinodon, Testes, ...5.0246

Environmental Physiology

DEVELOPMENT OF TECHNIQUES FOR THE AQUACULTURE OF POMPANO ...Aquaculture & Fish-farming, Florida, Maturity & Growth Stages, Pathology, Tuna, Mackerel, Albacore... , ...8.0007

MICROBIOLOGICAL ASSAYS OF SEAWATER USING RADIOISOTOPES ...Aquatic Ecology, Ciliates, Environmental Ecology, Food Chains, Phytoplankton, Productivity - Food Chain, Thiamine, ...5.0811

SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES ...Behavior, Fish -non-specific, Migration, Orientation, Sensory Organs, ...5.0338

STUDIES IN THE PHYSIOLOGY AND BIOCHEMISTRY OF DEEP-SEA FISHES ...Fish -non-specific, Metabolism, Vertical Distribution, Water Pressure, ...5.0237

PHYSIOLOGY OF MARINE MAMMAALS ...Mammals, Seals, ...5.0624

COMPARATIVE BEHAVIOR OF HATCHERY-REARED AND WILD SALMONIDS ...Atlantic Salmon, Sebago Salmon, Behavior, Captive Rearing, Lake Trout, Brook Trout, ...5.0264

STUDIES OF FISH ENDOCRINOLOGY ...Fresh Water, Hormone, Killifishs - Cyprinodon, Testes, Thyroid, ...5.0246

EXPERIMENTAL AND BIOMATHEMATICAL ANALYSIS OF THE PHENOMENON OF ATTACK ...Behavioral Ecology, Bluegills, Bream, Computer Methods -general, Largemouth Bass, Minnows, Predation, ...5.0535

NUTRITION AND PHYSIOLOGY OF MARINE FISH IN CONTROLLED GNOTOBIOTIC ENVIRONMENTS ...Aquaria, Fish -non-specific, Germ Free Animal, Nutrition -other, ...5.0317

ZOOPHYSIOLOGY OF OCEANIC BENTHIC ANIMALS OFF THE NORTH CAROLINA COAST ...Adaptation, Atlantic Ocean-north, Benthic Fauna, Benthonic-bottom, Water Temperature-non-specific, ...5.1009

THERMALMETABOLIC RELATIONSHIPS OF STENOTHERMAL FISHES ...Antarctica, Fish -non-specific, Proprioceptors, Thermonegulation, Water Pressure, Water Temperature-non-specific, ...5.0312

SENSORY BASIS OF NAVIGATION IN HOMING PIGEONS ...Behavior, Biological Rhythms, Locomotion -animal, Mark, Tag Or Capture -other, Pigeon, ...4.0108

ORIENTATION CUES AND PATTERNS OF LONG-DISTANCE TRAVEL OF MARINE TURTLES ...Biological Rhythms, Migration, Orientation, Turtles, Terrapins, Tortoises, ...4.0102

BEHAVIOR AND SONIC ACTIVITY OF FISHES ...Behavioral Ecology, Fish -other, Sonar, Sound Production, ...1.0047

PRESSURE EFFECTS ON MARINE ORGANISMS ...Abyssal, Pressure, Vertical Distribution, Water Pressure, ...5.0943

ESTUARINE WATER QUALITY AND FISH DISTRIBUTION ...Contamination - Water, Estuaries, Pollution Effects, Pulp, Paper , and Logging, Salmon & Trout - Non-specific, ...5.0178

CHEMICAL RESPONSES BY MARINE ORGANISMS TO STRESS ...Environmental Changes, Environmental Ecology, Protein, Salinity, Thermal, ...5.1026

THE INFLUENCE OF ENVIRONMENTAL FACTORS UPON DEVELOPING MERISTIC STRUCTURES IN THE MARINE FISH, FUNDULUS MAJALIS (WALBAUM) ...Basic Embryology, Developmental Physiology, Killifishs - Cyprinodon, Water Temperature-non-specific, ...5.0298

RELATION OF TEMPERATURE TO RHYTHMIC BEHAVIOR ...Behavior, Biological Rhythms, Bluefish, Locomotion -animal, Low Temp. -but Above 32f, ...**5.0284**

RHYTHMIC ACTIVITY OF BLUEFISH IN RELATION TO NORMAL LIGHT REGIME ...Biological Rhythms, Bluefish, Locomotion -animal, Photoperiod, ...**5.0285**

RHYTHMIC ACTIVITY OF BLUEFISH UNDER EXPERIMENTALLY VARIED LIGHT REGIMES ...Adaptation, Biological Rhythms, Bluefish, Photoperiod, Water Light Quality & Quantity, ...**5.0286**

METHODS OF REARING EGGS AND LARVAE TO JUVENILE STAGES ...Aquaculture & Fish-farming, Captive Rearing, Fish -non-specific, Maturity & Growth Stages, ...**8.0010**

EFFECTS OF CHEMICALS ON THE PHYSIOLOGY OF SEA LAMPREY AMMOCETES (PETROMYZON MARINUS) ...Contamination - Water, Control of Nuisance Species, Lampreys, Maturity & Growth Stages, ...**5.0631**

PHYSIOLOGY AND BEHAVIOR ...Behavior, Chemical Measurements -water, Lake Michigan, Physical Measurements - water, Productivity - Food Chain, ...**5.0904**

BEHAVIOR OF LARVAL FISHES ...Behavior, Captive Rearing, Commercial Fishing, Fish -non-specific, Maturity & Growth Stages, ...**5.0062**

ESTABLISHMENT AND PERPETUATION OF STOCKS OF EXPERIMENTAL FISH ...Behavior, Environmental Ecology, Fish -non-specific, Great Lakes-general, Life History Studies, ...**5.0109**

PINK SALMON INVESTIGATIONS - EARLY SEA LIFE OF SALMON ...Alaska, Life History Studies, Parasitology -other, Water Temperature-non-specific, ...**5.0187**

FISH BEHAVIOR AND PHYSIOLOGY ...Behavior, Engineering Structures-general, Migration, Salmon & Trout - Non-specific, Thermal Pollution, ...**5.0331**

INVESTIGATE PHYSIOLOGY OF TUNAS ...Behavior, Blood - other, Muscle, Olfactory, Tuna, Mackerel, Albacore... , ...**5.0259**

PHYSIOLOGY OF MARINE ORGANISMS ...Energy, Fish -non-specific, Food Supply, ...**5.0939**

FEEDING BEHAVIOR ...Alewife,menhaden,shad,herring, Anchovies, Behavior, Food Supply, Sensory Organs, ...**5.0040**

REARING MARINE FISH ...Alewife,menhaden,shad,herring, Anchovies, Captive Rearing, Tuna, Mackerel, Albacore... , ...**5.0041**

THE PHYSIOLOGY OF TUNA AND OTHER PELAGIC FISH ...Blood -other, Sharks, Thermonegulation, Tuna, Mackerel, Albacore... , ...**5.0272**

OSMOTIC COMPONENTS IN ELASMOBRANCH BLOOD ...Blood Plasma and Serum, Chondrichthyes -other, Osmoregulation, Water Salinity, Water Temperature-non-specific, ...**5.0249**

Immunology

USEFUL BIOMEDICAL MATERIALS DERIVED FROM THE SEA - AN INTERDISCIPLINARY APPROACH ...Antibody Formation, Bioluminescence, Molec. struct. (gen. & Other), ...**6.0106**

GERMFREE FISH ...Captive Rearing, Fish -other, Germ Free Animal, Infectious Conditions and Dis, Vertebrate Anatomy, ...**5.0236**

BLOOD TYPES AS INDICATORS OF BLUEFISH RACES ...Blood Cells, Blood Plasma and Serum, Blood Typing Studies, Bluefish, Polymorphism, ...**5.0319**

IMMUNOLOGY AND SEROLOGY OF MARINE ANIMALS ...Agglutination Tests, Biochemical Analysis, Blood Plasma and Serum, Pathology, ...**5.0977**

PACIFIC FISH PHYSIOLOGY AND BIOCHEMISTRY (SALMON IMMUNOCHEMISTRY) ...Maturity & Growth Stages, Salmon -coho,chinook,sockeye.., Stress, ...**5.0332**

PHYSIOLOGY AND ASSAY OF PROLACTIN IN FISH ...Bioassays, Biochemical, Gambusia, Molly, Luteotrophic Hormone, Pituitary, ...**5.0329**

Locomotion -animal

CARDIOVASCULAR ADJUSTMENT TO DIVING ASPHYXIA ...Cardiovascular System, Medical Studies, Regional Blood Flow & Volume, Seals, ...**5.0552**

DEEP DIVING ANTARCTIC BIRDS AND MAMMALS ...Adaptation, Antarctica, Penguins, Seals, Water Pressure, ...**5.0555**

SENSORY BASIS OF NAVIGATION IN HOMING PIGEONS ...Behavior, Biological Rhythms, Environmental Physiology, Mark, Tag Or Capture -other, Pigeon, ...**4.0108**

DISTANT GOAL ORIENTATION ...Biological Rhythms, Birds - non-specific, Magnetic Impulses, Mark, Tag Or Capture -other, Orientation, ...**4.0109**

BEHAVIORAL STUDIES OF CETACEANS ...Behavioral Ecology, Mammals, Sound Production, ...**5.0596**

APPLICATION OF BIOTELEMETRY TO THE STUDY OF MARINE VERTEBRATES ...Biological Sciences, Central Nervous System, Fish -non-specific, Telemeters, Telemetry, ...**5.0637**

STUDY OF FISH MUCUS BIOCHEMISTRY ...Fish -non-specific, Mucus, ...**8.0172**

RELATION OF TEMPERATURE TO RHYTHMIC BEHAVIOR ...Behavior, Biological Rhythms, Bluefish, Environmental Physiology, Low Temp. -but Above 32f, ...**5.0284**

RHYTHMIC ACTIVITY OF BLUEFISH IN RELATION TO NORMAL LIGHT REGIME ...Biological Rhythms, Bluefish, Environmental Physiology, Photoperiod, ...**5.0285**

CTFM SONAR ...Behavioral Ecology, Commercial Fishing, Sonar and Echo Sounding, Telemetry, Tuna, Mackerel, Albacore... , ...**8.0058**

CARDIOVASCULAR ADJUSTMENTS IN DIVING MAMMALS ...Adaptation, Cardiovascular System, Effects on Cardiovasc. system, Mammals, ...**5.0674**

CARDIOVASCULAR STUDIES ON DIVING MAMMALS ...Adaptation, Basic Hemodynamics, Cardiovascular System, Control and Regulation, Heart, Seals, ...**5.0639**

Metabolism

Energy

ENERGY REQUIREMENTS OF MARINE ORGANISMS ...Sharks, Thermonegulation, Tuna, Mackerel, Albacore... , Water Pressure, ...**5.0273**

Metabolism

COMPARATIVE STUDY OF NITROGEN SECRETION IN FISHES ...Comparative Physiology, Fish, Nitrogen, Vertebrate Anatomy, ...**5.1022**

CAROTENOIDS, CAROTENOID CHROMOPROTEINS, AND ASSOCIATED LIPIDS IN ANIMALS ...Carotenoid Pigments, Catabolism and Degradation, Pigments - Animal-non-specific, ...**5.0944**

STUDIES IN THE PHYSIOLOGY AND BIOCHEMISTRY OF DEEP-SEA FISHES ...Environmental Physiology, Fish -non-specific, Vertical Distribution, Water Pressure, ...**5.0237**

MORPHOLOGIC REGULATORY MECHANISMS IN TERRESTRIAL AND MARINE ORGANISMS ...Amphibia -non-specific & Other, Collagen, Developmental Physiology, Fish - other, Porifera, ...**5.0982**

REGULATION OF AMMONIA EXCRETION IN FISH AND AQUATIC AMPHIBIA ...Ammonium, Anura -other, Fish - other, Kidney and Urinary System, Water, ...**5.0269**

ECOLOGICAL EFFECTS OF ENVIRONMENTAL & LOW LEVEL POLLUTION STRESSES ON METABOLIC REQUIREMENTS FOR GROWTH OF GULF COAST FISHES ...Environmental Ecology, Gulf of Mexico, Pollution - Effects of , Pollution Effects, Pollution Sources-general, Stress, ...**5.0328**

PHYSIOLOGICAL STUDIES ON FISHES LACKING HEMOGLOBIN ...Adaptation, Cardiovascular System, Fish, Fish -other, Hemoglobin, Polar, ...**5.0241**

METABOLISM OF COMPLETE WATER COLUMNS ...Antarctic Ocean, Autotrophic, Energy Budgets, Respiration, ...**5.0967**

BIOCHEMISTRY AND PHYSIOLOGICAL ECOLOGY OF POISONED FISH ...Enzymes -non-specific, Fish -non-specific, Muscle, Pathology, Toxins -non-specific, ...**5.0305**

VITAMIN A AND PROTEIN METABOLISM ...Cellular Membranes (non-spec.), Ochromonas, Plasma Membrane, Vitamin A, ...**5.1006**

RATE OF ABSORPTION OF ENDRIN BY BLUEGILL SUNFISH ...Bioassay, Bluegills, Bream, DDT , Endrin, Mode of Action -animal, ...**5.0263**

Water

REGULATION OF AMMONIA EXCRETION IN FISH AND AQUATIC AMPHIBIA ...Ammonium, Anura -other, Fish - other, Kidney and Urinary System, Metabolism, ...**5.0269**

Metamorphosis

SEA LIONS ...Mammal Studies -other, Mark, Tag Or Capture - other, Maturity & Growth Stages, Seals, Spawning & Nesting Sites, ...**5.0526**

SEA OTTER ...Alaska, Population Dynamics, Range Or Territorial Distr. , Sea Lions, Fur Seals, Stocking of Mammals, ...5.0528

HAIR SEALS ...Age, Dispersion -other, Population Dynamics, Seals, Spawning & Nesting Sites, ...5.0525

Musculoskeletal System

Bone

SYSTEMATICS AND DISTRIBUTION OF WORMFISHES (MICRODESMIDAE) ...Animal Taxonomy, Collections, Fish -other, Vertebrate Anatomy, Vertical Distribution, ...5.0115

MONOGRAPH OF THE FISHES OF THE ORDER PLECTOGNATHI ...Animal Taxonomy, Comparative Anatomy, Fish -other, Pubilications -other, Vertebrate Anatomy, ...5.0146

BLOOD CHEMISTRY OF FISHES ...Blood Plasma and Serum, Sharks, Vertebrate Anatomy, Vertical Distribution, ...5.0239

SAMPLING OF GROUNDFISH STOCKS ...Age, Codfishes, Hake, Proprioceptors, Righteye Flounders, Size, ...5.0160

STUDIES IN MARINE CHEMISTRY ...Chemistry, Trace Elements, ...7.0068

SYSTEMATICS AND ZOOGEOGRAPHY OF THE BLENNIOID FISHES ...Animal Taxonomy, Fish -other, Nomenclature, Classification, World Wide, ...5.0051

OSTEOLOGY AND EVOLUTION OF ISOSPONDYLOUS AND OSTARIOPHYSAN FISHES ...Fish -other, Organic Evolution, Vertebrate Anatomy, ...5.0053

AGE DETERMINATION OF LARGE ATLANTIC SHARKS ...Age, Atlantic Ocean-north, Growth Rate, ...5.1028

INVESTIGATION OF THE BIOLOGY AND POPULATION STRUCTURE OF GULF MENHADEN ...Alewife,menhaden,shad,herring, Gulf of Mexico, Handbooks, Population Dynamics, Vertebrate Anatomy, ...5.0128

IDENTIFICATION OF SOCKEYE SALMON STOCKS BY BONE MINERALS ...Animal Taxonomy, Chemical Analysis, Pacific Ocean-general, Salmon -coho,chinook,sockeye.., ...5.0333

Muscle

BIOCHEMISTRY AND PHYSIOLOGICAL ECOLOGY OF POISONED FISH ...Enzymes -non-specific, Fish -non-specific, Metabolism, Pathology, Toxins -non-specific, ...5.0305

BIOCHEMISTRY OF FISH MUSCLE AND QUALITY CHANGES ...Enzymatic, Fish -non-specific, Food Raw Quality, Organoleptic Studies, ...5.1035

INVESTIGATE PHYSIOLOGY OF TUNAS ...Behavior, Blood -other, Environmental Physiology, Olfactory, Tuna, Mackerel, Albacore... , ...5.0259

ACTIONS OF BIO-TOXINS ON CELL MEMBRANES ...Nervous System, Plasma Membrane, Venom, ...6.0128

Nervous System

SENSORY PROCESSES, MARINE AND HUMAN ...Bioelectric Phenomena, Pathways, Sensory Organs, Visual, ...5.0969

ACTIONS OF BIO-TOXINS ON CELL MEMBRANES ...Muscle, Plasma Membrane, Venom, ...6.0128

Central Nervous System

COMMUNICATIONS STUDIES ON TURSIOPS TRUNCATUS AND OTHER DELPHINIDS ...Linguistics, Mammals, Neuristors Neurol Nets, Sound Production, ...5.0587

DEVELOPMENTAL ANALYSIS OF FUNDULUS ...Basic Embryology, Fats, Killifishs - Cyprinodon, Phospholipids, Transplants, ...5.0316

PHYSIOLOGICAL STUDIES IN THE BOTTLENOSE DOLPHIN TURSIOPS TRUNCATUS ...Adaptation, Cardiovascular System, Mammals, ...5.0588

APPLICATION OF BIOTELEMETRY TO THE STUDY OF MARINE VERTEBRATES ...Biological Sciences, Fish -non-specific, Locomotion -animal, Telemeters, Telemetry, ...5.0637

STUDIES ON INTEGRATIVE MECHANISMS OF NEURONS ...Brain, Mathematical Biophysic, Visual Organs, ...5.0635

ACOUSTICAL COMMUNICATION IN AQUATIC ORGANISMS ...Auditory, Biological Rhythms, Orientation, Sound Production, ...5.0318

THE CETACEAN BRAIN - A COMPARATIVE STUDY ...Comparative Physiology, Mammals, Structure-cell-tiss, ...5.0641

BEHAVIOR IN EMBRYOS AS IT RELATES TO ENCEPHALIZATION ...Basic Embryology, Behavior, Bullheads, Developmental Physiology, Visual Organs, ...5.0270

Osmoregulation

IONOCYTE FORMATION IN GILL EPITHELIUM OF FISHES ...Biosynthesis, Developmental Physiology, Differentiation Mechanism, Fish, Fish -non-specific, ...5.0301

RENAL SALT EXCRETION IN MARINE BIRDS ...Kidney and Urinary System, Shorebirds-gulls,terns,skimmer, Urine, ...5.0562

ENDOCRINE REGULATED PROCESSES IN TELEOST FISHES ...Comparative Physiology, Environment Resistance, Fish -other, Hypophysectomy, Pituitary, ...5.0288

DISTRIBUTION AND MIGRATION OF CENTRAL AMERICAN FRESHWATER ELASMOBRANCHS ...Caribbean Sea, Migration, Nicaragua, Rays, Skates, Mantas, Sawfish, Sharks, ...5.0117

FUNCTION OF THE INTERRENAL GLAND IN TELEOST FISHES ...Blood Cells, Kidney and Urinary System, Pituitary, Tilapia, Cichlids, Water Salinity, ...5.0233

MARINE PHYSIOLOGY ...Cardiovascular System, Fish, Thermonegulation, Water Pressure, ...5.0947

OSMOREGULATION ...Aquatic Ecology, Rays, Skates, Mantas, Sawfish, Sharks, Streams, ...5.0280

RENIN AND EURYHALINITY ...Comparative Physiology, Histochemistry - Cytochem, Kidney and Urinary System, Renin, Vertebrates -non-specific, ...5.0973

OSMOTIC COMPONENTS IN ELASMOBRANCH BLOOD ...Blood Plasma and Serum, Chondrichthyes -other, Environmental Physiology, Water Salinity, Water Temperature-non-specific, ...5.0249

Pigments

Visual

FURTHER STUDIES ON A FLUORESCENT COMPOUND IN THE DOGFISH LENS ...Fluorescent, Sharks, Visual Organs, ...5.0271

RETINAL RHYTHMS UNDER CONTROLLED LIGHT ...Bluefish, Darkness, Histology and Cytology, Light Quantity -non-specific, Visual Organs, ...5.0282

PHOTOBIOLOGY OF MARINE ANIMALS ...Bioluminescence, Fish -non-specific, Vertebrate Anatomy, Visual Organs, ...5.0327

PHOTOBIOLOGY OF MARINE ANIMALS ...Photochemistry, Photoreception, Physical State, Visual Organs, ...5.0313

Respiratory System

Fish

IONOCYTE FORMATION IN GILL EPITHELIUM OF FISHES ...Biosynthesis, Developmental Physiology, Differentiation Mechanism, Fish -non-specific, Osmoregulation, ...5.0301

COMPARATIVE STUDY OF NITROGEN SECRETION IN FISHES ...Comparative Physiology, Metabolism, Nitrogen, Vertebrate Anatomy, ...5.1022

PHYSIOLOGICAL STUDIES ON FISHES LACKING HEMOGLOBIN ...Adaptation, Cardiovascular System, Fish -other, Hemoglobin, Metabolism, Polar, ...5.0241

RESPIRATORY EXCHANGE IN FISH GILLS ...Gases, Submersibles, ...5.0267

MARINE PHYSIOLOGY ...Cardiovascular System, Osmoregulation, Thermonegulation, Water Pressure, ...5.0947

BIOLOGICAL TRANSPORT OF GASES AND OTHER SUBSTANCES ...Active Transport, Carbon Dioxide, Carbonic Anhydrase, Gases, Kidney and Urinary System, ...5.0240

Mammals

PHYSIOLOGY OF MARINE MAMMAALS ...Environmental Physiology, Seals, ...5.0624

PHYSIOLOGICAL STUDIES IN THE BOTTLENOSE DOLPHIN TURSIOPS TRUNCATUS ...Adaptation, Cardiovascular System, Central Nervous System, ...5.0588

CIRCULATORY REACTIONS TO ASPHYXIA ...Cardiovascular System, Effects on Cardiovasc. system, Veterinary Science, ...5.0553

COMPARATIVE PHYSIOLOGY OF RESPIRATORY MECHANICS IN MAMMALS ...Comparative Physiology, ...5.0612

Sensory Organs

FACTORS AFFECTING THE BEHAVIOR OF SHARKS ...Behavior, Sharks, ...5.0262

SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES ...Behavior, Environmental Physiology, Fish -non-specific, Migration, Orientation, ...5.0338

SENSORY PROCESSES, MARINE AND HUMAN ...Bioelectric Phenomena, Nervous System, Pathways, Visual, ...5.0969

ACOUSTICO-LATERALS FUNCTION IN FISH ORIENTATION AND COMMUNICATION ...Auditory, Behavior, Fish -non-specific, Orientation, Signal Detection, ...5.0289

SCHOOLING BEHAVIOR IN FISHES ...Behavior, Fish -non-specific, Social Behavior, Visual Organs, ...5.0125

SONIC SENSITIVITY OF FISHES AND AMPHIBIA ...Auditory, Comparative Physiology, Fish -non-specific, Frogs, ...5.0960

FEEDING BEHAVIOR ...Alewife,menhaden,shad,herring, Anchovies, Behavior, Environmental Physiology, Food Supply, ...5.0040

Auditory

PERCEPTUAL, VOCAL, AND ECHO-RANGING BEHAVIOR OF SEALS AND SEA LIONS ...Echolocation, Seals, Sound Production, Visual Organs, ...5.0547

RENEWAL RESEARCH PROPOSAL FOR HEARING AND ALLIED SENSES IN FISHES ...Behavior, Fish -non-specific, Sound Production, ...5.0254

ACOUSTICO-LATERALS FUNCTION IN FISH ORIENTATION AND COMMUNICATION ...Behavior, Fish -non-specific, Orientation, Sensory Organs, Signal Detection, ...5.0289

AUDITORY CAPACITIES OF TELEOST FISHES ...Audition, Behavior, Fish -other, Vertebrate Anatomy, ...5.0291

EXPERIMENTAL ANALYSIS OF HEARING AND ACOUSTIC ORIENTATION IN SHARKS ...Behavior, Shark Repellents, Sharks, ...5.0235

BEHAVIOR AND SENSORY PHYSIOLOGY OF SHARKS ...Behavioral Ecology, Fish Repellents, Sharks, Tape Recording, Audio, Visual Organs, ...5.0253

SONIC SENSITIVITY OF FISHES AND AMPHIBIA ...Comparative Physiology, Fish -non-specific, Frogs, Sensory Organs, ...5.0960

ACOUSTICAL COMMUNICATION IN AQUATIC ORGANISMS ...Biological Rhythms, Central Nervous System, Orientation, Sound Production, ...5.0318

Olfactory

SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES ...Behavior, Migration, Salmon & Trout - Non-specific, Visual Organs, ...5.0339

INVESTIGATE PHYSIOLOGY OF TUNAS ...Behavior, Blood -other, Environmental Physiology, Muscle, Tuna, Mackerel, Albacore... , ...5.0259

Proprioceptors

SIMULATED WEIGHTLESSNESS IN FISH ...Behavior, Cardiovascular System, Fish -non-specific, Gravitational Fields, Gravity, ...5.0275

THERMALMETABOLIC RELATIONSHIPS OF STENOTHERMAL FISHES ...Antarctica, Environmental Physiology, Fish -non-specific, Thermonegulation, Water Pressure, Water Temperature-non-specific, ...5.0312

SAMPLING OF GROUNDFISH STOCKS ...Age, Bone, Codfishes, Hake, Righteye Flounders, Size, ...5.0160

BIOSTATISTICS OF HERRING ...Age, Alewife,menhaden,shad,herring, Atlantic Ocean-north, Environmental Ecology, Growth Rate, Population Dynamics, ...5.0099

Visual Organs

VISUAL CAPACITIES IN TELEOST FISHES ...Behavior, Behavioral Ecology, Fish -other, Vertebrate Anatomy, Vision, ...5.0290

PERCEPTUAL, VOCAL, AND ECHO-RANGING BEHAVIOR OF SEALS AND SEA LIONS ...Auditory, Echolocation, Seals, Sound Production, ...5.0547

SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES ...Behavior, Migration, Olfactory, Salmon & Trout - Non-specific, ...5.0339

SCHOOLING BEHAVIOR IN FISHES ...Behavior, Fish -non-specific, Sensory Organs, Social Behavior, ...5.0125

BEHAVIOR AND SENSORY PHYSIOLOGY OF SHARKS ...Auditory, Behavioral Ecology, Fish Repellents, Sharks, Tape Recording, Audio, ...5.0253

THE SPECTRAL SENSITIVITY OF THE GREEN SEA TURTLE (CHELONIA MYDAS) ...Light Quality -non-specific, Turtles, Terrapins, Tortoises, ...5.0560

FURTHER STUDIES ON A FLUORESCENT COMPOUND IN THE DOGFISH LENS ...Fluorescent, Sharks, Visual, ...5.0271

RETINAL RHYTHMS UNDER CONTROLLED LIGHT ...Bluefish, Darkness, Histology and Cytology, Light Quantity -non-specific, Visual, ...5.0282

LIGHT AND DARK ADAPTION IN THE RETINAE OF YOUNG BLUEFISH ...Adaptation, Bluefish, Photoperiod, Retina, ...5.0283

VISUAL PROJECTION IN SUBMAMMALIAN VERTEBRATES ...Basic Studies, Cranial and Nuclii, Fish -other, Retina, ...5.0238

STRUCTURE AND FUNCTION OF EYES ...Vertebrate Anatomy, ...5.0379

STUDIES ON INTEGRATIVE MECHANISMS OF NEURONS ...Brain, Central Nervous System, Mathematical Biophysic, ...5.0635

BEHAVIOR IN EMBRYOS AS IT RELATES TO ENCEPHALIZATION ...Basic Embryology, Behavior, Bullheads, Central Nervous System, Developmental Physiology, ...5.0270

PHOTOBIOLOGY OF MARINE ANIMALS ...Bioluminescence, Fish -non-specific, Vertebrate Anatomy, Visual, ...5.0327

PHOTOBIOLOGY OF MARINE ANIMALS ...Photochemistry, Photoreception, Physical State, Visual, ...5.0313

Skin Or Special Derivatives

CELLULAR DIFFERENTIATION ...Active Transport, Basic Embryology, Differentiation Mechanism, Frogs, Ionic Effect, ...5.0618

Dermal

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...Hypertrophy - Hyperplasia, Lymphocystis, Neoplasm, Yellow Perch, Darters, ...5.0292

REGULATION OF IONIC CONSTITUTENTS OF PROTOPLASM ...Active Transport, Ions (inorganic), Musculoskeletal System, Nervous System, Osmoregulation, ...5.0970

Hair

FUR SEAL RESEARCH, ANATOMY-BEHAVIOR-MORTALITY ...Behavior, Mortality Rates, Nutrition -other, Seals, Vertebrate Anatomy, ...5.0672

Scales

ANALYSIS OF SALMONID SCALES ...Age, Animal Taxonomy, Columbia River, Growth Rate, Rainbow Trout, Steelhead Trout, Salmon -coho,chinook,sockeye.., ...5.0315

AGE AND GROWTH OF BLUEFISH ...Age, Atlantic Ocean-north, Bluefish, Growth Rate, Population Dynamics, ...5.0287

FLUCTUATIONS IN SPECIES COMPOSITION AND YEAR-CLASS STRENGTH OF COMMERCIAL LANDINGS ...Commercial Fishing, Lake Erie, Lakes, Size, Species, Comparison of , ...5.0135

OCEAN GROWTH AND MORTALITY OF SALMON ...Growth Rate, Mortality Rates, Salmon -coho,chinook,sockeye.., Tags, ...5.0170

GULF OF ALASKA SOCKEYE SALMON SCALES, PROTOCOL AREA SOCKEYE SALMON SCALES, AND GULF OF ALASKA PINK SALMON SCALES ...Animal Taxonomy, Gulf of Alaska, Life History Studies, Salmon -coho,chinook,sockeye.., ...5.0334

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ENERGY REQUIREMENTS OF MARINE ORGANISMS ...Energy, Sharks, Tuna, Mackerel, Albacore... , Water Pressure, ...5.0273

PHYSIOLOGY OF MARINE MAMMAALS ...Environmental Physiology, Mammals, Seals, ...5.0624

THERMALMETABOLIC RELATIONSHIPS OF STENOTHERMAL FISHES ...Antarctica, Environmental Physiology, Fish -non-specific, Proprioceptors, Water Pressure, Water Temperature-non-specific, ...5.0312

MARINE PHYSIOLOGY ...Cardiovascular System, Fish, Osmoregulation, Water Pressure, ...5.0947

THE PHYSIOLOGY OF TUNA AND OTHER PELAGIC FISH ...Blood -other, Environmental Physiology, Sharks, Tuna, Mackerel, Albacore... , ...5.0272

Vetebrate Physiology

Urogenital System

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REGULATION OF AMMONIA EXCRETION IN FISH AND AQUATIC AMPHIBIA ...Ammonium, Anura -other, Fish -other, Metabolism, Water, ...5.0269

RENAL SALT EXCRETION IN MARINE BIRDS ...Osmoregulation, Shorebirds-gulls,terns,skimmer, Urine, ...5.0562

FUNCTION OF THE INTERRENAL GLAND IN TELEOST FISHES ...Blood Cells, Osmoregulation, Pituitary, Tilapia, Cichlids, Water Salinity, ...5.0233

BIOLOGICAL TRANSPORT OF GASES AND OTHER SUBSTANCES ...Active Transport, Carbon Dioxide, Carbonic Anhydrase, Fish, Gases, ...5.0240

RENIN AND EURYHALINITY ...Comparative Physiology, Histochemistry - Cytochem, Osmoregulation, Renin, Vertebrates -non-specific, ...5.0973

Venom

VENOMOUS FISHES AND SEA SNAKES OF SOUTHEAST ASIA ...Behavior, Fish -non-specific, Snakes, Southeast Asia, Vertebrate Anatomy, ...6.0101

THE MORPHOLOGY, HISTOCHEMISTRY, AND MODE OF SECRETION IN THE VENOM GLAND OF SEA SNAKES ...Endocrine -other, Histochemistry - Cytochem, Snakes, Vertebrate Anatomy, ...5.0529

ACTIONS OF BIO-TOXINS ON CELL MEMBRANES ...Muscle, Nervous System, Plasma Membrane, ...6.0128

Veterinary Science

CIRCULATORY REACTIONS TO ASPHYXIA ...Cardiovascular System, Effects on Cardiovasc. system, Mammals, ...5.0553

Viral Studies

Biochemical Studies

Composition

MORPHOGENESIS OF THE BACTERIOPHAGE ...Electron Microscopy, Escherichia Coli, Metabolic-biochemical Genetics, Microorganism Proteins, Morphological Action, ...5.0792

Virgin Islands

LIFE-HISTORY AND BIOLOGICAL WORK IN THE RESTORATION AND MANAGEMENT OD SPECIES OF IMPORTANCE TO THE FISHERIES OF THE VIRGIN ISLANDS ...Commercial Fishing, Diving and Scuba, Life History Studies, Management -other, Population Dynamics, ...5.0149

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THE MARINE ALGAE OF VIRGINIA ...Algae- General, Benthonic-bottom, Chesapeake Bay, Marine Plants, Plant Taxonomy, ...5.0698

BIOLOGY OF ANADROMOUS ALOSIDS ...Alewife,menhaden,shad,herring, Mortality Rates, Spawning & Nesting Sites, Streams, Tidal Streams, ...5.0150

BIOLOGICAL AND CHEMICAL STUDY OF VIRGINIA'S ESTUARIES ...Estuaries, Nitrogen, Phosphorus, Phytoplankton, Population Dynamics, Primary Productivity, ...1.0158

STRATIGRAPHIC RELATIONS BETWEEN A COQUINA FACIES OF THE YORKTOWN FORMATION AND OVERLYING SEDIMENTS AT CHUCKATUCK, VIRGINIA ...Fossil Limestone, Sea Level Changes, Shore Features-general, Tertiary Period, Unconformities, ...7.0254

DISTRIBUTION AND ABUNDANCE OF OYSTER DRILLS (UROSALPINX CINEREA) IN THE JAMES RIVER, VIRGINIA ...Aquatic Ecology, Gastropods -slugs,conch,snails, Number Or Density, Streams, Vertical Distribution, ...5.0508

BENTHIC MARINE FAUNA OF THE UPPER SHELF OFF VIRGINIA ...Animal Taxonomy, Benthic Fauna, Benthonic-bottom, Continental Shelf, Organism Sampling Devices, ...5.0660

INFAUNA OF LOWER CHESAPEAKE BAY ...Aquatic Ecology, Chesapeake Bay, Population Dynamics, Shrimp - Amphipods, Streams, ...5.0661

OCEAN WATER INTRUSION INTO BACK BAY, VIRGINIA, & CURRITUCK SOUND, NORTH CAROLINA, ON THE WATERFOWL & FRESHWATER FISH HABITAT ...Habitat Studies, North Carolina, Water Salinity, Waterfowl -non-specific, ...5.0897

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Animal Viruses (non-specific)

TISSUE CULTURE - VIROLOGY ...Bacteria (non-specific), Cell Injury and Autolysis, Marine Biology, Monolayer Culture, Oysters, Tissues, ...5.0978

PURIFICATION OF HARD CLAMS FROM POLLUTED WATERS ...Clams, Contamination - Water, Estuaries, Intestinal Bacteria, New Jersey, ...5.0467

Papovaviruses

Papillomas of Animals

EPIDERMAL PAPILLOMAS IN PLEURONECTID FISHES ...Cancer, Pathology, Puget Sound, Righteye Flounders, ...5.0314

Picornaviruses

Enteroviruses of Humans

ENTEROVIRUSES IN DEPURATED HARD CLAMS, MERCENARIA MERCENARIA ...Clams, Detection, Microbiological Analysis, Sanitation, ...6.0057

Viruses of Fish

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CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...Dermal, Hypertrophy - Hyperplasia, Neoplasm, Yellow Perch, Darters, ...5.0292

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Ascorbic Acid

NUTRITIVE VALUE OF FISH AND OTHER MARINE PRODUCTS ...Fish -non-specific, Nutritive Value, Paper Chromatography, Proteins -non-specific, Thiamine, ...6.0054

Thiamine

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ISOLATION OF ANTI-THIAMINE FACTORS IN HAWAII FISH ...Fish -non-specific, Food Spoilage Detection, Radiation, Thiamine Compounds, Vitamins, ...5.0261

Thiamine Compounds

ISOLATION OF ANTI-THIAMINE FACTORS IN HAWAII FISH ...Fish -non-specific, Food Spoilage Detection, Radiation, Thiamine, Vitamins, ...5.0261

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EFFECT OF LIPIDS ON STABILITY OF BIOLOGICAL MEMBRANES ...Cellular Membranes (non-spec.), Coenzyme Q, Electron Microscopy, Stability, Vitamin A, ...5.1007

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VITAMIN A AND PROTEIN METABOLISM ...Cellular Membranes (non-spec.), Metabolism, Ochromonas, Plasma Membrane, ...5.1006

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VITAMIN K5 AS A FOOD PRESERVATIVE ...Food Bacteria, Food Processing -other, Microbiological, Repression, ...6.0075

Warning-systems

LOOK-OUT ASSIST DEVICE ...Fog-haze-mist, Navigation, Navigation Communication, Radar, Visibility, ...8.0146

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A TRAINING PROGRAM FOR GRADUATE STUDENTS IN MARINE SCIENCES AT THE FRIDAY HARBOR LABORATORIES ...Marine Biology, Marine Biology (non-specific), Training Grants, Fellowships, ...11.0042

DETAILED STUDY OF THE OCEANIC CRUST BY MEANS OF DEEP SEISMIC PROFILING ...Continental Shelves, Heat Flow Measurements, Seismic Studies, Subbottom, Textures-structures, ...7.0152

SEISMIC, MAGNETIC, AND ACOUSTIC STUDIES ON THE CONTINENTAL MARGIN OFF WASHINGTON ...Acoustical, Continental Shelf, Mechanical Properties, Subbottom, Textures-structures, ...7.0151

PROPERTIES AND ORIGIN OF SEDIMENTS IN THE NORTHEAST PACIFIC OCEAN ...Carbon-14, Core Analysis, Origin, Pacific Ocean-east, Physical Properties, ...7.0287

OCEANOGRAPHIC PROCESSES IN ESTUARINE AND COASTAL WATERS ...Oceanic Fronts, Pacific Ocean-east, Puget Sound, Shoreline - Coastline, Water Properties-general, ...4.0050

TAGGING ENGLISH SOLE, PETRALE SOLE, AND PACIFIC COD ...Codfishes, Hake, Commercial Fishing, Migration, Righteye Flounders, Size, Tags, ...5.0158

TAG LOSS ...Captive Rearing, Salmon -coho,chinook,sockeye.., Size, Tags, Weight, ...5.0157

MEASUREMENT OF SPAWNING SUCCESS AND FRY QUALITY OF CHUM SALMON UTILIZING A SPAWNING CHANNEL AT BIG BEEF CREEK, WASHINGTON ...Management -other, Number Or Density, Quality -non-specific, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, ...5.0229

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INFLUENCE OF INDUSTRIAL AND MUNICIPAL WASTES ON ESTUARINE AND OFF SHORE WATER QUALITY ...Domestic Wastes-general, Estuaries, Industrial Wastes, Pollution - Effects of , ...6.0192

OREGON-WASHINGTON NEARSHORE ...Distribution, Heavy Minerals, Oregon, Shoreline - Coastline, Terrigenous, ...7.0022

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TIME DEPENDENT VARIATIONS IN SURFACE OCEANIC CIRCULATION ...Circulation-general, Ocean History, Pollution Sources-general, Sedimentary History, Temperature, ...2.0038

THE INSTITUTE FOR THE DEVELOPMENT OF RIVERINE AND ESTUARINE SYSTEMS (IDRES) ...Delaware River, Estuaries, ...12.0043

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MODEL ADVANCED WASTE-TREATMENT PLANT ...Lime Treatment, Material Recovery Wastes, Pilot Plant, Process Design, Solid Waste, ...8.0326

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Lime Treatment

MODEL ADVANCED WASTE-TREATMENT PLANT ...Activated Carbon, Material Recovery Wastes, Pilot Plant, Process Design, Solid Waste, ...8.0326

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SUPPORTING TECHNOLOGY AT NAVAL RESEARCH LABORATORY ...Abyssal, Fouling, Microorganisms (non-specific), Submersibles, ...**8.0217**

ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...Clays, Distribution, Sedimentation, ...**1.0075**

QUANTITATIVE AND QUALITATIVE CHARACTERISTICS OF MATERIALS CONTRIBUTING TO SEDIMENTATION IN LAKE ERIE ...Lake Erie, Location, Organic, Rate of Deposition, Sedimentation, ...**7.0246**

INTERNATIONAL WEDDELL SEA OCEANOGRAPHIC EXPEDITION ...Population Dynamics, Primary Productivity, Productivity - Food Chain, Seals, Weddell Sea, ...**4.0121**

Trace Elements

CLAY-INORGANIC AND ORGANIC-INORGANIC ASSOCIATIONS IN AQUATIC ENVIRONMENTS ...Clays, Deposits, Mineral Reactions, Sedimentation, Suspension, ...**7.0050**

RADIOELEMENT STUDIES IN THE OCEANS - LANTHANIDES IN SEA WATER AND THEIR INTERACTIONS WITH MARINE SEDIMENTS AND SUSPENSOIDS ...Atlantic Ocean-general, Lanthanide Series, Oceanic Fronts, Radiochemical Analysis, Water Analysis, ...**1.0104**

CHEMICAL OCEANOGRAPHY ...Biogeochemical Process, Circulation-general, Geologic, Organics, Rare Earth Studies, ...**1.0129**

SEA WATER CHEMISTRY ...Atmosphere Composition, Gases, Industrial-general, Lead, Technique Development, ...**1.0076**

DETERMINATION OF TRITIUM IN NATURAL WATERS ...Nuclear Explosions - Fallout, Radioactivity, Tracers, Tritium, ...**1.0083**

DISTRIBUTION OF CARBON AND RADIUM IN THE ANTARCTIC WATERS ...Carbon, Gases, Indian Ocean-general, Radium, Sampling, ...**1.0109**

FACTORS INFLUENCING THE INTENSITY OF BIOLUMINESCENCE ...Bioluminescence, Cell. env.(non-specific & Ot.), Kinetics, Marine Biology, Optical, ...**1.0169**

CHEMICAL STUDIES OF THE OCEANIC ENVIRONMENT ...Chemical Reactions, Marine Biology, Mixing, Oceanic Fronts, Pacific Ocean-east, Water Analysis-general, ...**1.0136**

CHRONOLOGY OF MARINE SEDIMENTS, CIRCULATION OF WATER AND TRACE ELEMENTS, SEDIMENTARY RECORD AND EXTRATERRESTRIAL ACCRETION ...Circulation-general, Cosmogenous, Pacific Ocean-general, Paleoclimatology, Sedimentary History, ...**1.0098**

STUDIES IN MARINE CHEMISTRY ...Bone, Chemistry, ...**7.0068**

MARINE BIOLOGY PROGRAM Distribution, Productivity - Food Chain, Puerto Rico, Radioecology, Rare Earths, ...**1.0128**

FALLOUT INVENTORY OF THE OCEANS AND RELATED MECHANISMS ...Activation Analysis, Radioactivity, Radioactivity-general, ...**6.0189**

RADIOISOTOPE TRACERS IN OCEANOGRAPHIC RESEARCH ...Circulation-general, Radioactivity-general, Sampling, Tracers, ...**2.0001**

TRACE ELEMENT EQUILIBRIUM STUDIES ...Adsorption, Chelating Agents, Ion Exchange, Material Recovery, Tracers, ...**1.0088**

ISOTOPIC OCEANOGRAPHY ...Arctic Ocean, Data Acquisition, Oceans - Sea Water, Radioactivity-general, Sampling, ...**1.0090**

CHEMICAL OCEANOGRAPHY ...Aquatic Ecology, Circulation-general, Convection, Technique Development, ...**1.0134**

Water Analysis-general

SEAWATER/SEDIMENT/BIOLOGY MONITORING PROGRAM ...Data Acquisition, Marine Biology, Sediments-other, ...**1.0144**

ANALYSIS OF SEA WATER BY DIFFERENCE CHROMATOGRAPHY ...Interstitial - Connate Water, Ion Exchange, Runoff, Salinity, ...**1.0110**

LIGHT IN THE SEA ...Index of Refraction, Optical, Scattering, Tracers, Water Motion, ...**1.0168**

ELECTROLYTE-NON-ELECTROLYTE INTERACTIONS IN SEA WATER AND RELATED SOLUTIONS ...Alkali Metals, Alkaline Earths, Complexes, Electrolytes, Saline Water Systems, Thermal Properties-other, ...**1.0107**

SUPPORT FOR THE OPERATION OF OCEANOGRAPHIC RESEARCH VESSELS ...Black Sea, Marine Biology, Mediterranean Sea-general, Sedimentation, Ships and Cruises, ...**11.0030**

PHYSICAL AND CHEMICAL ATLAS ...Atlases-maps, Convection, General Sea Water Chemistry, Indian Ocean-general, Water Properties-general, ...**4.0026**

SIGNIFICANCE OF FLUORIDE VARIATIONS IN SEA WATER ...Atlantic Ocean-general, Chloride, Element Ratios, Extrusives, Fluoride, ...**1.0105**

HEAVY METAL GEOCHEMISTRY OF ANTARCTIC SEA WATER AND MARINE SEDIMENTS ...Antarctic Ocean, Chemistry, Circulation-general, Sedimentation, ...**1.0086**

DEEP OCEAN AS RECIPIENT OF VOLATILES AND SOLUTES ...Hydrothermal Minerals, Igneous Activity - Volcanism, Lithology, Pacific Ocean-east, Ridges, Sea Floor Spreading, Thermal Features, ...**7.0095**

CHEMICAL STUDIES OF THE OCEANIC ENVIRONMENT ...Chemical Reactions, Marine Biology, Mixing, Oceanic Fronts, Pacific Ocean-east, Trace Elements, ...**1.0136**

CHEMICAL OCEANOGRAPHY ...Arctic, Circulation-general, Isotope Tracer-other, Oceanic Fronts, Tracers, ...**1.0072**

SHIPBOARD METHODS OF CHEMICAL ANALYSIS ...Caribbean Sea, Gases, Mass Spectroscopy, Solubility, Technique Development, ...**1.0091**

COASTAL AND INSHORE OCEANOGRAPHY ...Alaska, Estuaries, Marine Biology, Shoreline - Coastline, Water Properties-general, ...**5.0851**

CHEMICAL METHODOLOGY - APPLICATIONS OF NITRATE SPECIFIC ELECTRODE TO CHEMICAL OCEANOGRAPHY ...Electrode, ...**1.0093**

Water Chemistry-other

SEDIMENTARY GEOCHEMISTRY ...Authigenesis, Other, Precipitation, Removal--inorganics, ...**7.0190**

MEASUREMENT OF SURFACE CHARGE ON PARTICLES SUSPENDED IN SEA WATER ...Electrical, Suspension, Zeta Potential, ...**7.0205**

MINERALOGICAL STUDIES OF PARTICULATE MATTER SUSPENDED IN SEA WATER ...Chemistry, Mineralogy, Suspension, ...**1.0122**

ELEMENT CHEMISTRY ...Atomic Absorption, Element Ratios, Industrial Wastes, Oceanic Fronts, ...**1.0113**

STABLE ISOTOPES ...Atlantic Ocean-north, Atlantic Ocean-south, Carbon, Chemical Analysis (water), Sampling, ...**1.0108**

PH STANDARD REFERENCE MATERIALS FOR USE IN SEA WATER ...pH , Salinity, Standards, Specifications, Water Analysis, ...**1.0087**

Water Cycle

FIELD EXPERIMENTS ON THE FLUX OF RADIONUCLIDES THROUGH A SALT MARSH ECOSYSTEM ...Chlorideae (non-specific & Ot), Georgia, Model Studies, Productivity - Food Chain, Swamps-marshes, ...**5.0965**

Water Demand

ECONOMICS OF WATER QUALITY FOR A REGIONAL SYSTEM ...Delaware River, Economic Efficiency, Estuaries, Finance, Regional Areas, Water Quality-general, ...**9.0018**

Water Harvesting

HYDROLOGY OF UPPER OLD TAMPA BAY, FLORIDA ...Bays, Groundwater Movement, Hydrology-general, Lakes, Permeability, Water Quality-general, ...**2.0067**

Water Level Fluctuation

GEOLOGICAL STUDIES IN NORTHERN LAKE MICHIGAN ...Deposits-other, Lake Michigan, Lakes, Rocks - Bedrock, Submergent, ...**7.0164**

BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SALT MARSH ENVIRONMENT -...Aquatic Soils, Core Analysis, Identification, Marine Bacteria, Salinity, Swamps-marshes, Temperature, ...**5.0763**

THE NET EFFECT OF WIND ON RECREATIONAL TIDAL STREAMS IN FLORIDA ...Air-sea Boundary-other, Estuaries, Florida, Tides, Wind-general, ...**2.0082**

GREAT LAKES RESEARCH - WATER-LEVEL DISTURBANCES ...Lake Erie, Lake Michigan, Model Studies, Sea Level Variations, Seiches, ...**2.0086**

GREAT LAKES RESEARCH - HARBOR CURRENTS ...Great Lakes-general, Harbors, Model Studies, Ocean Currents-other, Pressure-density, Wind-water Interaction, ...**2.0074**

HYDRAULICS AND DYNAMICS OF ESTUARIES ...Erosion-general, Estuaries, Flow Characteristics -water, Sedimentation, Sedimentology-general, Waves, ...**7.0102**

Water Motion

GULF STREAM EDDIES ...Data Analysis - General, Data Reduction and Analysis, Gulf Stream, Hydrodynamics, Temperature, ...**2.0028**

OCEAN KINEMATICS DYNAMICS ...Chesapeake Bay, Circulation-general, Data Reduction and Analysis, Estuaries, Turbulent Flow, ...**2.0069**

TURBULENT DIFFUSION STUDY ...Chesapeake Bay, Dispersion -water, Estuaries, Tracers-general, Turbulent Flow, ...**2.0056**

DELAY LINE COMPUTER ...Acoustical, Heat and Radiation Transfer, Hybrid Computer Applications, Meteorological Studies, Model Studies, ...**4.0080**

LONG RANGE SOFAR FLOATS ...Acoustical, Currents-ocean, Physical Analysis, Subsurface Environments, Water Motion Recorders, ...2.0025

LIGHT IN THE SEA ...Index of Refraction, Optical, Scattering, Tracers, Water Analysis-general, ...1.0168

STUDY OF OCEANIC TURBULENCE ...Energy, Hydrodynamics, Mixing, Subsurface Environments, Turbulence - Sea Water, ...2.0055

STUDIES OF BARACLINIC TIDAL MOTIONS ON THE CONTINENTAL SHELF OF THE EASTERN UNITED STATES ...Continental Shelf, Eastern, Meteorological Studies, Sea Level Variations, Tides, ...2.0081

STUDY OF STABILITY AND SHEAR IN THE TOP 500 METERS OF THE OCEAN ...California Current, Density, Mixing, Water Motion Recorders, ...1.0171

USE OF ON-LINE COMPUTERS FOR ENVIRONMENTAL RESEARCH ...Acoustical, Air-sea Boundary-general, Development of Models, Hybrid Computer Applications, Meteorological Studies, ...4.0081

BUOY ENGINEERING ...Buoys, Experiments and Tests, Moorings, ...8.0309

INVESTIGATION OF THE CIRCULATION OF LAKE SUPERIOR ...Circulation-general, Lake Superior, Model Studies, Stratified Flow, Temperature, Thermodynamics, ...2.0048

CURRENT STUDY ON THE NEUSE RIVER AND ESTUARY ...Discharge, Dyes, Estuaries, North Carolina, Tracers, ...2.0037

EXPERIMENTAL AND THEORETICAL STUDY OF THE HYDRODYNAMICS OF DISPERSION IN RIVERS AND ESTUARIES ...Dispersion -water, Estuaries, Flow Characteristics -water, Model Studies, Streams, ...2.0057

BIG EDDIES AND MIXING PROCESSES IN THE GREAT LAKES ...Circulation -water, Dispersion -water, Effluents-waste Water, Great Lakes-general, Mixing, ...2.0052

OCEANOGRAPHIC RESEARCH ...Acoustical, Density, Gases, Marine Biology, Thermal, ...1.0142

SHALLOW WATER ACOUSTIC PROPAGATION STUDIES (SWAPS) ...Acoustical, Geomorphology-topography, Liquids, Subbottom, Thermal, Transmission, Turbulence - Sea Water, Waves, ...1.0065

OCEANOGRAPHIC RESEARCH-INVESTIGATIONS IN SHALLOW WATER ...Acoustical, Environmental Effects-geologic, Model Studies, Salinity, Thermal, ...1.0009

GENERAL COASTAL INLET STUDIES ...Coastal Engineering-other, Coastlines-shorelines, Discharge, Model Studies, Synthetic Hydrology, Tides, ...7.0125

GREAT LAKES RESEARCH - RIVER ICE JAMS ...Great Lakes general, Ice Jam, Streams, Survey Studies, ...3.0081

Water Motion Recorders

NUCLEAR OCEANOGRAPHIC TECHNIQUES ...Currents-ocean, Isotope Dilution, Physical Properties, Radioactivity, Water Analysis, ...8.0087

WATER WAVE DOCUMENTATION ...Buoys, California, Pacific Ocean-general, Waves, ...2.0094

OCEAN CIRCULATION STUDIES ...Acoustical, Atlantic Ocean-north, Currents-ocean, Hydrodynamics, Statistics-general, Waves-internal, ...2.0040

OCEAN WAVES AND TIDES ...Currents-ocean, Subsurface Environments, Thermal, Tides, Waves, ...2.0080

DESIGN AND DEVELOPMENT OF OCEANOGRAPHIC INSTRUMENTATION ...Bottom Sampling Device, Physical Analysis, Technique Development, ...8.0090

OCEAN CURRENT TRANSPORT ...Gulf Stream, Navigation, Ocean Waves - Currents, ...2.0016

HIGH FREQUENCY WAVES ...Forecasting-prediction, Heat and Radiation Transfer, Hydrodynamics, Waves, ...2.0113

LONG RANGE SOFAR FLOATS ...Acoustical, Currents-ocean, Physical Analysis, Subsurface Environments, Water Motion, ...2.0025

VERTICAL MOTIONS ...Convection, Gulf Stream, Hydrodynamics, ...2.0060

DEEP-SEA AUTONOMOUS VEHICLES, INSTRUMENTS, BASIC CONTROL DEVICES, AND SPECIAL COLLECTING GEAR ...Abyssal, Bottom Sampling Device, Organism Sampling Devices, Photography, Sampling, Submersibles, ...8.0122

STUDY OF OCEAN CURRENTS AT SEA FLOOR AND THEIR SPACTIAL CORRELATION ...Benthonic-bottom, Currents-bottom, Field Characteristics, ...2.0003

OCEANOGRAPHY, PLEISTOCENE GEOLOGY AND SEDIMENTS OF LITTLE BAHAMA BANK ...British West Indies, Carbonates-general, Currents-bottom, Energy, Quaternary Period, ...7.0229

DEEP FLOW, WATER CHARACTERISTICS, TOPOGRAPHY AND SEDIMENTS IN THE CENTRAL PACIFIC AREA ...Abyssal, Currents-bottom, Distribution, Geomorphology-topography, Pacific Ocean-general, Structural Studies, ...7.0032

STUDIES OF THE TRANSPORT OF THE FLORIDA CURRENT ...British West Indies, Florida, Gulf Stream, Navigation, Ocean Currents-other, ...2.0017

NATURE AND VELOCITY OF CURRENTS AND OTHER FLOWS IN SUBMARINE CANYONS ...Convection, Fans, Ocean Waves - Currents, Sedimentation, Submarine Canyons, Turbidity Currents, ...2.0008

GULF STREAM TRANSPORT ...Automatic Stations, Gulf Stream, Hydrodynamics, Ships and Cruises, ...2.0029

STUDY OF LOW FREQUENCY SURFACE WAVES IN THE PACIFIC OCEAN ...Meteorological Studies, Sea Level Variations, Tides, Turbulence - Sea Water, Waves, ...2.0068

STUDY OF STABILITY AND SHEAR IN THE TOP 500 METERS OF THE OCEAN ...California Current, Density, Mixing, Water Motion, ...1.0171

HEAT FLOW MEASUREMENTS ...Atlantic Ocean-general, Geophysical Equipment, Heat Flow Measurements, Photography, Technique Development, ...7.0138

OCEAN BOTTOM EMPLACED GEOPHYSICAL STATION ...Automatic Stations, Benthonic-bottom, Dynamic Gravimeters, Geophysical Equipment, Gravity Studies, Instrumental Services, Pacific Ocean-east, Temperature, ...4.0035

CHARACTERISTICS, CAUSES, AND PREDICTION OF UPWELLING WATER MASSESS OFF OREGON ...Forecasting-prediction, Mixing, Oceanic Fronts, Oregon, Pacific Ocean-east, ...2.0062

OCEANIC INTERNAL MOTIONS AFFECTING OPERATIONS ...Bermuda, Buoys, Military Aspects, Thermal, Waves-internal, ...2.0115

MEASUREMENT AND INTERPRETATION OF MOTIONALLY-INDUCED ELECTRIC FIELDS IN THE SEA ...Currents-ocean, Electrical, Forecasting-prediction, Marine Environments-general, Model Studies, Moorings, ...1.0139

OCEAN DYNAMICS EXPERIMENTS ...Buoys, Moorings, Other-design-and-construction, Submersibles, Technique Development, Temperature, ...2.0072

OCEAN WAVES AND STRUCTURE ...Buoys, Salinity, Thermocline, Tides, Waves, ...2.0106

MEASUREMENT OF SURGING IN KUHIO BAY, HILO HAWAII ...Gaging, Harbors, Hawaii, Tsunami, Waves, ...2.0112

WAVE MEASUREMENT IN THE OPEN OCEAN ...Buoys, Data Acquisition, Oceanic - Pelagic, Profiles, Waves, ...2.0109

FOSDIC APPLICATION TO CURRENT-METER RECORDS ...Currents-ocean, Data & Statistics Storage, Recording Systems, Research - Development, Technique Development, ...4.0021

WATER CURRENT METERS ...Standards, Specifications, ...8.0079

ADVANCED RESEARCH - SATELLITE INTERROGATED ENVIRONMENTAL BUOY ...Buoys, Meteorological Studies, Navigation Communication, Satellites, ...8.0280

OCEANOGRAPHIC RESEARCH ...Acoustical, Hydrodynamics, Instrumentation-general, Moorings, Naval Architecture-general, ...1.0052

GREAT LAKES RESEARCH - LAKE WAVES ...Great Lakes-general, Shear, Waves, Wind-water Interaction, ...2.0118

WAVE RECORDING AND ANALYSIS ...Data Reduction and Analysis, Lasers-masers, Pressure, Radar, Sonar, Statistics-general, Waves, ...2.0101

RUBBLE-MOUND PROTOTYPE STUDIES ...Breakwaters, Jetty, Shoreline Structures, Wave Action, Waves, ...8.0042

CIRCULATION ON THE CONTINENTAL SHELF ...Atlantic Ocean-north, Circulation-general, Continental Shelf, Eastern, ...2.0027

Water Properties

Acoustical

HONEYWELL ACOUSTIC RESEARCH PROGRAM ...Data Acquisition, Data Analysis - General, Interfaces, Model Studies, Reverberation, Sonar, ...**1.0071**

ACOUSTIC IMAGE INVESTIGATION ...Reflection, Sonar, Technique Development, ...**1.0018**

ULTRASONICS ...Nonlinear Acoustics, Surface Environments, Ultrasonic Frequency, ...**1.0019**

STUDY OF PROBABILITY OF DETECTION AND FALSE ALARM RATE OF FREQUENCY ACOUSTIC TELEMETERING SYSTEM ...Interference, Oil and Natural Gas - Sulfur, ...**8.0106**

EFFECTS OF THERMAL MICROSTRUCTURE ON ACOUSTIC TELEMETRY ...Currents-other, Thermal, ...**1.0066**

PRESSURE INSENSITIVE VELOCIMETER ...Instrumental Services, Pressure, Transducers, Velocimeter, Velocity, ...**8.0055**

OCEANOGRAPHIC DATA SYSTEMS ...Data & Statistics Storage, Engineering Studies-other, Hydrodynamics, Instrumentation-general, Pollution Sources-general, ...**4.0013**

AMBIENT SEA NOISE INVESTIGATION ...Acoustic, Computer Applications, Noise, Waves, Wind-water Interaction, ...**1.0048**

MARINE GEOLOGY ...Bathymetry, Geomorphology-topography, Magnetic Studies, Mapping, Sea Floor Spreading, ...**7.0041**

DEEP SEA SEDIMENT STUDIES ...Marine Soils, Mechanical Properties, Physical Analysis, Physical Properties, Shear Strength, ...**8.0341**

OCEAN CIRCULATION STUDIES ...Atlantic Ocean-north, Currents-ocean, Hydrodynamics, Statistics-general, Water Motion Recorders, Waves-internal, ...**2.0040**

DELAY LINE COMPUTER ...Heat and Radiation Transfer, Hybrid Computer Applications, Meteorological Studies, Model Studies, Water Motion, ...**4.0080**

SEDIMENTATION ...Gravity Tectonics, Gulf of Mexico, Mass Wasting, Mechanical Properties, Sedimentation, ...**7.0281**

ARCTIC RESEARCH ...Arctic Ocean, Currents-ocean, Geomorphology-topography, Magnetic Studies, Sea Ice, ...**4.0049**

SEA FLOOR TOPOGRAPHY ...Abyssal, Geomorphology-topography, Seamounts-guyots, Sedimentation, Structural Studies, ...**7.0294**

LONG RANGE SOFAR FLOATS ...Currents-ocean, Physical Analysis, Subsurface Environments, Water Motion, Water Motion Recorders, ...**2.0025**

INERTIAL TECHNIQUES ...Currents-ocean, Hydrodynamics, Physical Analysis, ...**8.0099**

CIRCULATION STUDIES ...Caribbean Sea, Dispersion, Ocean Currents-other, Transmission, Water Properties-general, ...**1.0046**

PARTIAL DIFFERENTIAL EQUATIONS AND CONTINUUM MECHANICS ...Approximations, Ordinary, Partial, Waves, ...**8.0171**

EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS ...Conductivity, Density, Electrical, Electrolytes, Pressure, Sulfate, Sulfite, Viscosity, ...**1.0078**

DEVELOPMENT OF AN ADVANCED MISSILE IMPACT LOCATING SYSTEM FOR THE EASTERN TEST RANGE ...Area, Atlantic Ocean-north, Missile & Rockets, Navigation, Sound Gear, ...**8.0048**

BIO-ACOUSTIC AND BIOLOGICAL SAMPLING GEAR STUDIES ...Indian Ocean-general, Mapping, Organism Sampling Devices, Plankton (non-specific), ...**8.0126**

MARINE GEOPHYSICS ...Continental Shelf, Continental Slope, Mechanical Devices, Seismic Studies, Textures-structures, ...**7.0146**

DEEP-SEA SEDIMENTS - THEIR PROPERTIES AND PROCESSES OF FORMATION ...Basins, Currents-ocean, Depth, Origin, Panama, Physical Properties, ...**7.0273**

HOLOGRAPHIC STUDIES OF MARINE ORGANISMS ...Holography, Lasers-masers, Plankton (non-specific), Plant Prod. (non-specific), Sampling, ...**8.0060**

ACOUSTIC-VIDEO SYSTEM FOR AQUATIC BIOACOUSTICAL AND ETHOLOGICAL RESEARCH ...Behavioral Ecology, British West Indies, Marine Biology, Marine Environments-general, ...**1.0049**

USE OF ON-LINE COMPUTERS FOR ENVIRONMENTAL RESEARCH ...Air-sea Boundary-general, Development of Models, Hybrid Computer Applications, Meteorological Studies, Water Motion, ...**4.0081**

ISLAND-CURRENT INTERACTIONS ...Currents-ocean, Data Analysis - General, Geomorphology, Islands, Model Studies, ...**2.0116**

SEISMIC, MAGNETIC, AND ACOUSTIC STUDIES ON THE CONTINENTAL MARGIN OFF WASHINGTON ...Continental Shelf, Mechanical Properties, Subbottom, Textures-structures, Washington, ...**7.0151**

DETERMINATION OF EQUATION OF STATE, VISCOSITY AND COMPRESSIBILITY OF SEA WATER ...Currents-other, Density, Instrumentation-general, Salinity, Temperature, Viscosity, ...**1.0145**

DISTRIBUTIONS OF CURRENTS AND PHYSICAL PROPERTIES WITHIN THE ARCTIC OCEAN ...Arctic Ocean, Currents-ocean, Heat and Radiation Transfer, Sea Ice, Temperature, ...**4.0051**

EASTERN ATLANTIC AND MEDITERRANEAN OCEANOGRAPHY ...Atlantic Ocean-north, Bathymetry, Data Analysis - General, Mediterranean Sea-general, Oceanography-general, ...**1.0055**

FIELD DETECTION AND MEASUREMENT OF INTERNAL WAVES ...Density, Digital Computer Applications, Temperature, Tides, Waves-internal, ...**2.0125**

DETERMINANTS AND CONTROL OF UNDERWATER VOCALIZATIONS IN THE CALIFORNIA SEA LION ...Mammals, Seals, Sound Production, ...**1.0003**

ARCTIC SUB-ICE STUDY ...Arctic Ocean, Marine Biology, Sea Ice, Submersibles, ...**3.0074**

ARCTIC PLANKTON ECOLOGY ...Arctic, Marine Biology (non-specific), Oceanic Fronts, Plankton (non-specific), Population Dynamics, ...**1.0017**

RESEARCH IN CORE ANALYSIS ...Core Analysis, Coring and Dredging, Geomorphology-topography, Model Studies, Physical Properties, ...**7.0263**

RESEARCH IN OCEAN PROPERTIES ...Geomorphology-topography, Geophysical Equipment, Marine Biology, Model Studies, Seismic Studies, Subbottom, ...**7.0132**

RESEARCH IN OCEANOGRAPHIC SPECIAL CHARTS ...General Sediment Type, Geomorphology-topography, Model Studies, Seismic Reflection, Seismic Studies, Subbottom, ...**1.0062**

WATER MASS TRACERS ...Circulation-general, Currents-ocean, Oceanic Fronts, Tracers, ...**2.0020**

HF AUDIO ABSORPTION IN ICE ...Attenuation, Ice Acoustics, Reverberation, Salinity, Sea Ice, ...**3.0073**

ARCTIC RESEARCH LABORATORY ...Alaska, Arctic Ocean, Drift Stations, Seismic Studies, Terrain Analysis, ...**12.0003**

LARGE-SCALE INTERACTIONS ...Air-sea Boundary-general, Buoys, Pacific Ocean-north, Temperature, Thermal, ...**3.0006**

BOTTOM CURRENTS AND DEEP SEA TIDES ...Abyssal, Benthonic-bottom, Currents-other, Finite Differences, Model Studies, Tides, ...**2.0004**

INTERNAL WAVE STUDY ...Atlantic Ocean-north, Continental Shelf, Thermal, Tides, Waves-internal, ...**2.0099**

RESEARCH IN REGIONAL TOPOGRAPHIC ANALYSIS ...Geomorphology-topography, Seismic Studies, Sonar, Subbottom, ...**1.0063**

OCEANOGRAPHIC RESEARCH ...Forecasting-prediction, Submersibles, Temperature, ...**1.0161**

THERMAL PROPERTIES OF SEA WATER AT LOW TEMPERATURE AND HIGH PRESSURE ...Conduction, Expansion, Hydrodynamics, Physical Analysis, Thermal, ...**1.0177**

BIOLOGIC SOUND SCATTERING ...Population Dynamics, Reverberation, Scattering, Vertical Distribution, Zooplankton, ...**1.0060**

MARINE RADIOLOGICAL INSTRUMENTATION ...Chemical Analysis (water), Circulation-general, Laboratory Analysis, Mixing, Radioactivity-general, Sampling, ...**8.0062**

MOVABLE OCEAN MEASUREMENT SYSTEM ...Instrumental Services, Platforms, Spectral Distribution, Spectrum, ...**8.0117**

ACOUSTICS PHYSICS ...Liquids, Transmission, ...**1.0058**

ACOUSTIC SCATTERING ...Interfaces, Model Studies, Reflection, Scattering, Surface Environments, ...**1.0069**

SOUND TRANSMISSION IN THE SEA ...Signal Analysis-other, Sonar, Transmission, ...**1.0020**

UNDERWATER ACOUSTIC HOLOGRAPHIC DISPLAY ...Detectors, Holography, Instrumental Services, Photography, Recognition Systems, ...**8.0137**

SEA FLOOR ROUGHNESS ...Attenuation, Benthonic-bottom, Bottom Sampling Device, Magnetic Studies, Propagation, Transmission, ...**7.0033**

HUDSON LABORATORIES SHIP SUPPORT ...Facilities, Modification-conversion, Platforms, Scientific-service-support, Ships and Cruises, Special Mission Ships, ...12.0021

SHALLOW-WATER ACOUSTICS ...Survey Studies, Transmission, ...1.0050

OCEAN ACOUSTIC ENVIRONMENT ...Interfaces, Reverberation, Scattering, Transmission, ...1.0016

WOODS HOLE ENVIRONMENTAL STUDIES OF SEA FLOOR PROPERTIES ...Benthonic-bottom, Data Acquisition, Geomorphology-topography, Gravity Studies, Subbottom, ...7.0118

WOODS HOLE STUDY ACTIVITIES ...Consultants, Advisory Services, Engineering Studies-general, General Information Services, ...11.0031

WOODS HOLE ENVIRONMENTAL STUDIES IN PHYSICAL OCEANOGRAPHY ...Bathythermographs, Oceanic Fronts, Salinity, Temperature, Velocity, ...1.0056

WOODS HOLE ENVIRONMENTAL STUDIES OCEANIC ACOUSTICS ...Atlantic Ocean-north, Benthonic-bottom, Data Analysis - General, Reverberation, Scattering, ...1.0057

OCEAN SOUND TRANSMISSION ...Transmission, ...1.0061

ACOUSTIC AMBIENT NOISE ...Arctic, Liquids, Noise, Spectra, ...1.0053

BI-STATIC ECHO RANGING ...Liquids, Reverberation, ...1.0067

BELUGA WHALES ...Behavioral Ecology, Life History Studies, Mammals, Sound Production, Tape Recording, Audio, ...5.0527

DEVELOPMENT OF ANALYSIS TECHNIQUES AND EQUIPMENT FOR CLASSIFICATION OF TRANSIENT HYDROACOUSTIC SIGNALS ...Real Time Systems, Sonar, Technique Development, ...1.0070

DEVELOPMENT OF ANALYSIS TECHNIQUES FOR CLASSIFYING TRANSIENT HYDROACOUSTIC SIGNALS ...Acoustics, Seismic Studies, Signal Detection, Transient, ...1.0068

PHYSICAL ACOUSTICS AND THE PROPERTIES OF MATTER ...Cavitation, Constants, Ultrasonic Frequency, Velocimeter, Velocity, Water, ...1.0031

BASIC ACOUSTICAL STANDARDS AND MICROPHONE CALIBRATION ...Acoustic, Audio Frequency, Calibration and Calibrators, Standards, Specifications, Transducers, ...8.0076

RELIABLE ACOUSTIC PATH ...Attenuation, Bermuda, Ranging, Reverberation, Transmission, ...1.0032

ULTRASONICS ...Attenuation, Instrumentation- Non-specific, Transmission, Velocity, ...1.0036

OCEANOGRAPHIC RESEARCH ...Density, Gases, Marine Biology, Thermal, Water Motion, ...1.0142

MICROACOUSTICS ...Reflection, Scattering, Sound Gear, Water Tunnels Tables, ...1.0043

ENVIRONMENTAL REVERBERATION STUDIES ...Bubble, Electron, Liquids, Reverberation, Scattering, ...1.0039

SEA-AIR INTERACTION RESEARCH ...Heat and Radiation Transfer, Hydrodynamics, Salinity, Waves, ...3.0039

PHYSIOCHEMICAL AND ACOUSTIC PROPERTIES OF SEA WATER ...Electrical, Saline Water Systems, Solution, Thermal, ...1.0157

SHALLOW WATER ACOUSTIC PROPAGATION STUDIES (SWAPS) ...Geomorphology-topography, Liquids, Subbottom, Thermal, Transmission, Turbulence - Sea Water, Water Motion, Waves, ...1.0065

OCEAN DYNAMICS SEA AIR INTERACTION MODELS-MEDITERRANEAN ...Hydrodynamics, Mediterranean Sea-general, Model Studies, Surface Environments, Wind-water Interaction, ...3.0002

OCEAN DYNAMICS IN THE STRAITS OF GIBRALTAR AND ADJACENT AREAS ...Anti-submarine-warfare, Computer Applications, Hydrodynamics, Model Studies, Strait of Gibraltar, Submerged Ships, ...1.0141

OCEAN DYNAMICS - OCEANOGRAPHIC ANALYSES AND FORECASTING MODELS ...Air-sea Boundary-general, Hydrodynamics, Model Studies, Surface Environments, Temperature, ...1.0004

SEA FLOOR STUDIES - TOPOGRAPHY AND SHAPE OF THE SEA FLOOR ...Geomorphology-topography, Photography, Sedimentation, ...7.0293

OCEANOGRAPHIC RESEARCH ...Hydrodynamics, Instrumentation-general, Moorings, Naval Architecture-general, Water Motion Recorders, ...1.0052

OCEANOGRAPHIC RESEARCH ...Anti-submarine-warfare, California, Military Aspects, Temperature, Transmission, ...1.0005

OCEANOGRAPHIC RESEARCH - INVESTIGATIONS WITH THERMISTOR CHAIN ...Forecasting-prediction, Temperature, Thermal, Transmission, Water Properties-general, Waves-internal, ...1.0143

OCEANOGRAPHIC RESEARCH-INVESTIGATIONS IN SHALLOW WATER ...Environmental Effects-geologic, Model Studies, Salinity, Thermal, Water Motion, ...1.0009

PHYSICAL OCEANOGRAPHY ...Surface Environments, Temperature, Transmission, Velocity, Waves, ...1.0026

OCEANOMETRICS ...Forecasting-prediction, Statistics-general, Transmission, Velocity, ...1.0006

INTERNAL WAVE STUDIES ...Model Studies, Refraction, Scattering, Surface Environments, Waves-internal, ...1.0021

BIOLOGICAL OCEANOGRAPHY ...Atlantic Ocean-north, Marine Biology, Sound Production, Submersibles, ...1.0022

GEOLOGICAL OCEANOGRAPHY - ACOUSTICAL PROPERTIES OF SEDIMENTS ...Core Analysis, Geomorphology-topography, Mechanical Properties, Physical Properties, Scattering, ...7.0101

INTERNAL WAVE RESEARCH ...Surface Environments, Tides, Waves, Waves-internal, ...2.0096

OCEANOGRAPHIC RESEARCH ...Buoys, Currents-ocean, Optical, Pressure, Seismic Studies, Sonar, ...1.0151

SHALLOW WATER OCEANOGRAPHY ...Continental Shelf, Hydrodynamics, Rhode Island, Surface Environments, Transmission, ...1.0030

DEEP OCEAN ACOUSTIC RESEARCH ...Abyssal, Pressure, Submersibles, Textures-structures, Transmission, Velocity, ...1.0010

ACOUSTIC PROPERTIES OF SEDIMENTS ...Correlation, Physical Properties, Seismic Studies, Subbottom, Texture, ...7.0108

GLOBAL VOLUME REVERBERATION LIMITATION STUDIES ...Atlantic Ocean-north, Reverberation, Scattering, Sound Production, ...1.0037

ADVANCED TECHNOLOGY AND BOTTOM PREDICTIONS ...Benthonic-bottom, Data Acquisition, Data Analysis - General, Forecasting-prediction, Model Studies, Seismic Studies, ...1.0045

SYSTEM OPERATIONS AND ACOUSTIC PHYSICS ...Economic Theory, Instrumentation-general, Liquids, Standards, Specifications, Systems Analysis, ...12.0020

GLOBAL OCEAN FLOOR ANALYSIS ...Bathymetry, Benthonic-bottom, Currents-bottom, Geomorphology-topography, Seismic Studies, Subbottom, ...4.0046

PREDICTIVE OCEAN ACOUSTICS ...Forecasting-prediction, Velocity, ...1.0033

PREDICTIVE OCEAN ACOUSTICS ...Environmental Effects-geologic, Forecasting-prediction, Transmission, Velocity, ...1.0034

SHALLOW WATER PROPAGATION ...Coherence, Reverberation, Shoals, Transmission, Water Properties-general, ...1.0035

UNDERWATER ACOUSTIC ANALYSIS ...Forecasting-prediction, Phase Relationships, Signal Analysis-other, Transmission, Water Properties-general, ...1.0038

SHALLOW WATER ACOUSTIC STUDIES ...Model Studies, ...1.0042

MEASUREMENT AND PREDICTIVE STATISTICS OF REVERBERATION ...Geomorphology-topography, Reverberation, Scattering, Surface Environments, Textures-structures, Velocity, ...1.0007

MEASUREMENT AND THEORY OF SCATTERED UNDERWATER SOUND ...Reflection, Scattering, Transmission, ...1.0008

UNDERWATER ACOUSTIC SIGNAL COHERENCE ...Coherence, Transmission, ...1.0012

MEASUREMENT OF UNDERWATER ACOUSTIC PROPAGATION ...Depth, Forecasting-prediction, Intensity, Transmission, ...1.0014

PREDICITION OF SOUND FIELDS BY NORMAL MODE AND OTHER THEORY ...Attenuation, Computer Applications, Transmission, ...1.0011

ACOUSTIC PROPAGATION STUDIES ...Instrumentation-general, Technique Development, Transmission, ...1.0044

AMBIENT SEA NOISE ...Buoys, Noise, Sampling, Sound Production, ...1.0013

UNDERWATER ACOUSTICS MEASUREMENTS FACILITY ...Facilities, Liquids, Transmission, ...12.0019

ARCTIC AND COLD WEATHER SUPPORTING TECHNOLOGY ...Ice Acoustics, Pressure, Sea Ice, Transmission, ...3.0079

SONAR ACCURACY ...Acoustic, Fire Control, Instrumental Services, Platforms, Sonar, Transmission, ...1.0051

BOTTOM-REFLECTED SONAR STUDIES ...Benthonic-bottom, Scattering, Sonar, Surface Environments, Transmission, ...1.0025

AMBIENT NOISE RESEARCH STUDIES ...Depth, Model Studies, Noise, Spectra, ...1.0023

SIGNAL COHERENCE AND ARRAY DESIGN STUDIES ...Coherence, Reflection, Signal Analysis-other, Spectra, Waveform, ...1.0024

REVERBERATION RESEARCH STUDIES ...Liquids, Reverberation, Water Properties-general, ...1.0027

ACOUSTIC SCATTERING STUDIES ...Interfaces, Reflection, Scattering, ...1.0028

ENVIRONMENTAL SUPPORT OF SONAR DESIGN ...Liquids, Model Studies, Ships and Cruises, Transmission, Water Properties-general, ...1.0015

UNDERWATER SOUND PROPAGATION STUDIES ...Attenuation, Liquids, Transmission, Water Properties-general, ...1.0029

ACOUSTIC HOLOGRAPHY ...Diffraction, Holography, Liquids, Ocean Mining, ...8.0255

Biological-general

PREDICTION OF ENVIRONMENT ...Columbia River, Environmental Ecology, Low Temp. -but Above 32f, Physical-general, Reservoirs and Impoundments, Salmon & Trout - Non-specific, Snake River, Temperature, Thermal Pollution, ...5.0225

Chemical-general

WATER PHYSICS AND CHEMISTRY ...Hydrodynamics, Infrared Radiation, Lasers-masers, Satellites, Thermal Pollution, ...4.0147

A SYMPOSIUM ENTITLED ORGANIC CHEMISTRY OF NATURAL WATERS ...Alaska, Meetings, Organic, Organic Matter, Organic-general, Organics, Organics-general, Polar, Sediments, Water Analysis, Water Chemistry, ...11.0001

RELATIONSHIPS BETWEEN PHOSPHATE AND OTHER CHEMICALS AT THE WATERSUBSTRATE INTERFACE IN WESTERN LAKE ERIE ...Aquatic Soils, Chemical, Lake Erie, Phosphate, Phosphite, Sediments, ...7.0078

CHEMICAL EXCHANGES ACROSS SEDIMENT-WATER INTERFACES ...Chemical, Estuaries, Exchange Capacity, Salinity, Solution Chemistry, ...7.0279

GREAT LAKES RESEARCH - CHARACTERISTICS OF LAKE WATER ...Great Lakes-general, Meteorological Studies, Ocean Currents-other, Physical-general, Water Quality-general, ...1.0154

REMOTE SENSING OF ESTUARINE WATER AND VEGETATION, MARYLAND ...Aerial Photography, Bioindicators, Estuaries, Physical-general, Remote Sensing -other, ...4.0144

SALT-WATER ENCROACHMENT IN NORTH CAROLINA ESTUARIES ...Estuaries, Flow Characteristics -water, Industrial-general, Saline Water Intrusion, Sampling, ...6.0168

PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE UPPER CHESAPEAKE BAY ...Chesapeake Bay, Crustacea - non-specific, Environmental Ecology, Mollusks -non-specific & Other, Physical-general, ...1.0150

CHEMISTRY OF THE HYPOLIMNION OF LAKE ERIE ...Ions and Gases, Lake Erie, Overturn, Oxygen, Stratification, ...1.0115

LAKE HURON CHEMICAL CONTROL ...Bioindicators, Ectoparasites, Flow Characteristics -water, Lake Huron, Selectivity, ...6.0159

Density

DYNAMICS OF INTERNAL WAVES AND TURBULENCE IN THE THERMOCLINE ...Salinity, Turbulence, Turbulent Flow, ...2.0093

PROPERTIES OF SEA WATER ...Compressibility--gas-liq, Conductivity, Electrical, Expansion, Physical Analysis, Thermal, ...1.0153

CIRCULATION OF THE PACIFIC ...Circulation-general, Oceanic Fronts, Pacific Ocean-general, Sampling, Subsurface Environments, ...2.0007

EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS ...Acoustical, Conductivity, Electrical, Electrolytes, Pressure, Sulfate, Sulfite, Viscosity, ...1.0078

DEVELOPMENT OF A SIMPLE UNATTENDED PYCNOCLINE FOLLOWER ...Hawaii, Heat and Radiation Transfer, Wind-water Interaction, ...8.0091

CIRCULATION AROUND OCEANIC ISLANDS ...Circulation-general, Islands, Mixing, Thermodynamics, Waves-internal, Wind-water Interaction, ...2.0010

STUDY OF STABILITY AND SHEAR IN THE TOP 500 METERS OF THE OCEAN ...California Current, Mixing, Water Motion, Water Motion Recorders, ...1.0171

DETERMINATION OF EQUATION OF STATE, VISCOSITY AND COMPRESSIBILITY OF SEA WATER ...Acoustical, Currents-other, Instrumentation-general, Salinity, Temperature, Viscosity, ...1.0145

MIXING PROCESSES INFLUENCING THE OCEANIC ENVIRONMENT ...Currents-ocean, Mixing, Model Studies, Moorings, Underwater-construction, ...2.0054

FIELD DETECTION AND MEASUREMENT OF INTERNAL WAVES ...Acoustical, Digital Computer Applications, Temperature, Tides, Waves-internal, ...2.0125

OCEANOGRAPHIC RESEARCH ...Acoustical, Gases, Marine Biology, Thermal, Water Motion, ...1.0142

INTERRELATIONS WITHIN THE PHYSICAL ENVIRONMENT ...Commercial Fishing, Environmental Ecology, Sea Level Variations, Temporal Distribution, ...2.0078

Depth

DEPTH CONTROLLED STREAMER DEVELOPMENT ...Control-systems, Equipment, Hydrographic, Sonar, ...8.0139

MARINE GEOCHEMISTRY RESEARCH ...Gases, Mineral Genesis, Mineralogy, Radioactive Dating, Sedimentation, Thermodynamics, ...7.0055

EFFECTS OF DEPTH ON GROWTH AND REPRODUCTION OF BENTHIC MARINE ALGAE ...Algal Culture, Growth and Differentiation, Phaeophyta (non-specific & Ot), Reproductive Physiology, Rhodophyta (non-specific & Ot), ...5.0684

MONOGRAPH OF THE CEPHALOPODS OF THE NORTH ATLANTIC ...Animal Taxonomy, Atlantic Ocean-north, Nomenclature, Classification, Optical, Pubilications -other, Salinity, Temperature, ...5.0411

WATER MASSES, CURRENTS AND ORIGIN OF THE ATLANTIC BOTTOM WATER IN THE WEDDEL SEA, ANTARCTICA ...Currents-bottom, Oceanic Fronts, Salinity, Sampling, Temperature, Weddell Sea, ...4.0134

THEORETICAL STUDIES OF TSUNAMI PROPAGATION ...Environmental Effects-geologic, Forecasting-prediction, Geomorphology-topography, Tsunami, Waves, ...2.0122

ANTARCTIC PHYSICAL OCEANOGRAPHY ...Antarctic Ocean, Currents-ocean, Photography, Salinity, Temperature, ...4.0133

DEEP-SEA SEDIMENTS - THEIR PROPERTIES AND PROCESSES OF FORMATION ...Acoustical, Basins, Currents-ocean, Origin, Panama, Physical Properties, ...7.0273

MULTISPECTRAL SENSING OF COASTAL ENVIRONMENTS ...Aerial Photography, Beaches, E M Radiation-general, Geomorphology-topography, Photography, Shoreline - Coastline, ...4.0166

OCEANOGRAPHIC RESEARCH ...Absorption Spectra, Non Specific, Optical, Optical Devices, Optical Systems, ...1.0167

DIGITAL RECORDING AND PROCESSING OF IN SITU DEPTH-TEMPERATURE-SALINITY DATA ...Bathythermographs, Error Analysis, Research - Development, Salinity, Temperature, ...4.0025

CHANGES IN THE LIMITING NUTRIENT DUE TO TEMPORAL, GEOGRAPHIC, AND DEPTH VARIATIONS ...New York, Nutrients, Phytoplankton, Sub - Tropic, Water Depth, Water Levels, ...5.1004

OCEAN RADIOACTIVITY ...Detectors and Sensors, Neutron Detectors, Proportional Counters, Radioactivity, ...1.0089

ELECTROMAGNETIC NOISE MEASUREMENTS IN THE SEA ...Benthonic-bottom, Electromagnetic, Submersibles, Surface Environments, ...1.0138

MEASUREMENT OF UNDERWATER ACOUSTIC PROPAGATION ...Acoustical, Forecasting-prediction, Intensity, Transmission, ...1.0014

AMBIENT NOISE RESEARCH STUDIES ...Acoustical, Model Studies, Noise, Spectra, ...1.0023

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION SUBARTIC OCEANOGRAPHY ...Currents-ocean, Pacific Ocean-north, Range Or Territorial Distr. , Salinity, Salmon -coho,chinook,sockeye.., Temperature, ...1.0159

TIME-SERIES OBSERVATIONS OF TEMPERATURE AND SALINITY (NORTH ATLANTIC AND NORTH PACIFIC OCEAN STATIONS) ...Atlantic Ocean-north, Pacific Ocean-north, Salinity, Sampling, Temperature, ...4.0005

BARBADOS OCEANOGRAPHIC AND METEOROLOGICAL EXPERIMENT ...British West Indies, Ocean-lakes, Salinity, Temperature, Wind-water Interaction, ...3.0015

Electrical

PROPERTIES OF SEA WATER ...Compressibility--gas-liq, Conductivity, Density, Expansion, Physical Analysis, Thermal, ...1.0153

MEASUREMENT OF SURFACE CHARGE ON PARTICLES SUSPENDED IN SEA WATER ...Suspension, Water Chemistry-other, Zeta Potential, ...7.0205

EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS ...Acoustical, Conductivity, Density, Electrolytes, Pressure, Sulfate, Sulfite, Viscosity, ...1.0078

MEASUREMENT AND INTERPRETATION OF MOTIONALLY-INDUCED ELECTRIC FIELDS IN THE SEA ...Currents-ocean, Forecasting-prediction, Marine Environments-general, Model Studies, Moorings, Water Motion Recorders, ...1.0139

PHYSIOCHEMICAL AND ACOUSTIC PROPERTIES OF SEA WATER ...Acoustical, Saline Water Systems, Solution, Thermal, ...1.0157

Electromagnetic

ELECTROMAGNETIC NOISE MEASUREMENTS IN THE SEA ...Benthonic-bottom, Depth, Submersibles, Surface Environments, ...1.0138

Heat Flow

INSTRUEMTATION FOR LAKE CAYUGA HEAT RELEASE STUDY ...Electric Power Plants, Lakes, New York, Temperature, Thermal Pollution, ...8.0105

Ions and Gases

STRONTIUM ISOTOPE COMPOSITION AND TRACE ELEMENT CONCENTRATIONS IN LAKE HURON AND ITS PRINCIPAL TRIBUTARIES ...Chemical, Lake Huron, Rocks - Bedrock, Strontium, Trace Element Analysis, ...1.0124

A STOCHASTIC MODEL FOR POLLUTION IN ESTUARIES ...Estuaries, Model Studies, Oxygen, Water Quality Control-general, Water Quality-general, ...6.0188

ENVIRONMENTAL CHANGES IN LAKE ERIE ...Aquatic Ecology, Environmental Changes, Environmental Ecology, Lake Erie, Nutrients, ...5.0903

CHEMISTRY OF THE HYPOLIMNION OF LAKE ERIE ...Chemical-general, Lake Erie, Overturn, Oxygen, Stratification, ...1.0115

Optical

MAN IN THE SEA - VISUAL ACUITY RESEARCH ...Acuity, Divers, Diving and Scuba, Experiments and Tests, Submersibles, ...6.0089

FISHERIES RESOURCES IDENTIFICATION AND ASSESSMENT ...Aerial Photography, Behavioral Ecology, Commercial Fishing, Fish -non-specific, Spectral Reflectance, ...4.0149

FLIGHT TESTING OF HIGH PERFORMANCE WIDE-RANGE IMAGE SPECTROPHOTOMETER (WISP) SYSTEM ...Aircraft, Spectral Reflectance, Technique Development, ...4.0152

LIGHT IN THE SEA ...Index of Refraction, Scattering, Tracers, Water Analysis-general, Water Motion, ...1.0168

OPTICAL MEASUREMENTS ...Benthonic-bottom, Currents-ocean, Photography, Subsurface Environments, ...1.0170

DATING MARINE SEDIMENTS ...Argon-potassium, Loess, Origin, Radioactive Dating, Rate of Deposition, Terrigenous, ...7.0201

MONOGRAPH OF THE CEPHALOPODS OF THE NORTH ATLANTIC ...Animal Taxonomy, Atlantic Ocean-north, Depth, Nomenclature, Classification, Pubilications -other, Salinity, Temperature, ...5.0411

AN OPTICAL METHOD OF MEASURING THE FORM OF THE FREE SURFACE OF A FLUID ...Fluid Dynamics, Free Surface Waves, Models, Optical Systems, Watersheds, Waves, ...2.0124

RESEARCH IN AIR-ENERGY EXCHANGE ...Heat and Radiation Transfer, Lasers and Masers, Thermal, Visible, ...3.0035

BIOLOGICAL PRODUCTIVITY INVESTIGATIONS OF THE WATERS SURROUNDING ANTARCTICA ...Organics, Phytoplankton, Primary Productivity, Standing Crops, Weddell Sea, ...5.1030

HYDROLOGIC OPTICS - SPACELIGHT SPECTROSCOPY ...Attenuation, Intensity, Oceanic Fronts, Phytoplankton, Radiograph, Radiometer, Scattering, Spectrophotometer, ...4.0139

OPTICAL OCEANOGRAPHY IN FLORIDA BAY, FLORIDA STRAITS AND BAHAMA BANK ...Distribution, Mixing, Optical Devices, Sedimentation, Wind-water Interaction, ...1.0163

THE OPTICAL PROPERTIES OF SEA WATER AND THEIR USE IN OCEANOGRAPHIC RESEARCH & DEVELOPMENT ...Attenuation, Oceanic Fronts, Oregon, Salinity, Suspension, Temperature, ...2.0091

FACTORS INFLUENCING THE INTENSITY OF BIOLUMINESCENCE ...Bioluminescence, Cell. env.(non-specific & Ot.), Kinetics, Marine Biology, Trace Elements, ...1.0169

GEOCHEMISTRY OF CARBONATE CYCLE IN THE MARINE ENVIRONMENT ...Calcium, Carbonate, Bicarbonate, Chemical Reactions, Precipitation, Removal--inorganics, ...7.0069

OCEANOGRAPHIC RESEARCH ...Absorption Spectra, Depth, Non Specific, Optical Devices, Optical Systems, ...1.0167

SEA WATER OPTICS STUDIES ...Estuaries, Size Frequency Distribution, Suspension, ...1.0166

OCEANOGRAPHIC RESEARCH ...Acoustical, Buoys, Currents-ocean, Pressure, Seismic Studies, Sonar, ...1.0151

Organic-general

A SYMPOSIUM ENTITLED ORGANIC CHEMISTRY OF NATURAL WATERS ...Alaska, Chemical-general, Meetings, Organic, Organic Matter, Organics, Organics-general, Polar, Sediments, Water Analysis, Water Chemistry, ...11.0001

STABLE CARBON AND OXYGEN ISOTOPE RATIO VARIATIONS IN THE FLOW TO CARBON AND OXYGEN THROUGH NORMAL AND POLLUTED AQUATIC SYSTEMS ...Carbon, Element Ratios, Oxygen, Pollutants - Path of , Sewerage Systems-other, Water Analysis, ...1.0132

Physical-general

ORGANIC DEBRIS ON CONNECTICUT BEACHES AND SHORES ...Catabolism and Degradation, Connecticut, Identification, Organic Matter, Shoreline - Coastline, ...6.0143

SPRING CHINOOK SALMON ECOLOGY STUDY ...Aquatic Ecology, Mark, Tag Or Capture -other, Oregon, Productivity (agricultural), Salmon -coho,chinook,sockeye.., Streams, ...5.0218

GREAT LAKES RESEARCH - CHARACTERISTICS OF LAKE WATER ...Chemical-general, Great Lakes-general, Meteorological Studies, Ocean Currents-other, Water Quality-general, ...1.0154

REMOTE SENSING OF ESTUARINE WATER AND VEGETATION, MARYLAND ...Aerial Photography, Bioindicators, Chemical-general, Estuaries, Remote Sensing -other, ...4.0144

INFLUENCE OF THE PHYSICAL ENVIRONMENT ON DISTRIBUTION OF YOUNG STAGES OF COASTAL GAME FISH ...Continental Shelf, Environmental Ecology, Fish -non-specific, Maturity & Growth Stages, Range Or Territorial Distr. , ...5.0211

PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE UPPER CHESAPEAKE BAY ...Chemical-general, Chesapeake Bay, Crustacea -non-specific, Environmental Ecology, Mollusks -non-specific & Other, ...1.0150

PREDICTION OF ENVIRONMENT ...Biological-general, Columbia River, Environmental Ecology, Low Temp. -but Above 32f, Reservoirs and Impoundments, Salmon & Trout - Non-specific, Snake River, Temperature, Thermal Pollution, ...5.0225

Pressure

PRESSURE INSENSITIVE VELOCIMETER ...Acoustical, Instrumental Services, Transducers, Velocimeter, Velocity, ...8.0055

PRECISION QUARTZ CAPACITANCE PRESSURE TRANSDUCERS ...Capacitance, Quartz, Technique Development, Transducers, ...8.0121

EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS ...Acoustical, Conductivity, Density, Electrical, Electrolytes, Sulfate, Sulfite, Viscosity, ...1.0078

EXPERIMENTAL STUDY OF THE INTERRELATIONS BETWEEN WIND-WAVE PROPERTIES ...Hydrodynamics, Mixing, Turbulence - Sea Water, Waves, Wind-water Interaction, ...2.0123

LONG-PERIOD WAVES ...Bermuda, Sea Level Variations, Statistics-general, Waves, ...2.0085
PRESSURE EFFECTS ON MARINE ORGANISMS ...Abyssal, Environmental Physiology, Vertical Distribution, Water Pressure, ...5.0943
OCEAN PRESSURE RESEARCH ...Military Aspects, Ordnance, Underwater Warfare, ...1.0173
OCEANOGRAPHIC RESEARCH ...Acoustical, Buoys, Currents-ocean, Optical, Seismic Studies, Sonar, ...1.0151
PHYSICAL PROPERTIES OF SEA WATER AT PRESSURE ...Heat Exchangers, Thermal, Viscosity, ...1.0149
CHEMICAL PROPERTIES OF SEA WATER AT PRESSURE ...Gases, General Sea Water Chemistry, Interstitial - Connate Water, Solubility, Viscosity, ...1.0099
SHALLOW WATER OCEANOGRAPHY ...Continental Shelf, Environmental Effects-geologic, Forecasting-prediction, Subsurface Environments, Waves, ...1.0172
DEEP OCEAN ACOUSTIC RESEARCH ...Abyssal, Acoustical, Submersibles, Textures-structures, Transmission, Velocity, ...1.0010
ARCTIC AND COLD WEATHER SUPPORTING TECHNOLOGY ...Acoustical, Ice Acoustics, Sea Ice, Transmission, ...3.0079
SUPPORTING SYSTEMS ...Facilities, Underwater-laboratory, ...8.0338
WAVE RECORDING AND ANALYSIS ...Data Reduction and Analysis, Lasers-masers, Radar, Sonar, Statistics-general, Water Motion Recorders, Waves, ...2.0101

Salinity

MILLSTONE POINT TEMPERATURE SURVEY ...Atomic Plants, Connecticut, Electric Power Plants, Temperature, ...1.0181
BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SALT MARSH ENVIRONMENT -...Identification, Marine Bacteria, Microbiological Analysis, Swamps-marshes, Temperature, ...5.0762
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CHEMICAL EXCHANGES ACROSS SEDIMENT-WATER INTERFACES ...Chemical, Chemical-general, Estuaries, Exchange Capacity, Solution Chemistry, ...7.0279
PALEOSALINITY DETERMINATION BY THE BORON IN ILLITE METHOD ...Boron, Illinois, Illite, Interstitial - Connate Water, Swamps-marshes, ...7.0238
AN ENVIRONMENTAL SURVEY OF THE DAMARISCOTTA RIVER ESTUARY, LINCOLN COUNTY, MAINE ...Circulation -water, Estuaries, Nutrients, Pollution - Effects of , Sedimentology-general, ...5.0895
FLOW AND SALINITY IN THE HUDSON ESTUARY, NEW YORK ...Estuaries, Fresh Water, Inflow, Management, Tides, ...2.0075

Stratification

CHEMISTRY OF THE HYPOLIMNION OF LAKE ERIE ...Chemical-general, Ions and Gases, Lake Erie, Overturn, Oxygen, ...1.0115
ESTUARINE DIFFUSION OF POLLUTANTS ...Dilution-other, Estuaries, Oregon, Pollutants - Path of , Salinity, ...6.0175

Temperature

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CALORIC - AN INVESTIGATION OF HEAT RELEASE PATTERNS ASSOCIATED WITH PRESENT AND PLANNED LAKESHORE ELECTRICAL POWER PLANTS ...Electric Power Plants, Lake Erie, Model Studies, Nuclear Power, Pollution - Effects of , Thermal Pollution, ...1.0186
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TIME DEPENDENT VARIATIONS IN SURFACE OCEANIC CIRCULATION ...Circulation-general, Ocean History, Pollution Sources-general, Sedimentary History, Waste Disposal-general, ...2.0038
GULF STREAM EDDIES ...Data Analysis - General, Data Reduction and Analysis, Gulf Stream, Hydrodynamics, Water Motion, ...2.0028
OCEAN CIRCULATION AND CONTROLLING FACTORS FOR PREDICTION ...Circulation-general, Meteorological Studies, Oceanic Fronts, Salinity, ...2.0034
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WHITECAPPING ...Meteorological Studies, Particle-gas Transfer, Velocity, Waves, Wind-water Interaction, ...2.0120
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BATHYTHERMOGRAPH ANALYSIS ...Bathythermographs, Critically Evaluated Data, Data Analysis - General, Model Studies, Salinity, Surface Environments, ...1.0178
CONTROLLED ENVIRONMENTAL FACTORS ON THE DEVELOPMENT OF ESTUARINE AND OCEANIC CRUSTACEA ...Aquatic Ecology, Crabs, Developmental Physiology, Estuaries, Salinity, ...5.0476
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TEMPERATURE AND SALINITY TOLERANCE OF THE SAND SHRIMP, CRANGON SEPTEMSPINSOA ...Environment Resistance, Environmental Physiology, Estuaries, Salinity, Shrimps - Common, ...5.0437
SUPPORT OF THE VERMILION SEA FIELD STATION AT BAHIA DE LOS ANGELES, BAJA CALIFORNIA ...Arid and Desert, Facilities, Gulf of California, Habitat Studies, Tides, ...12.0009
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TEMPERATURE MICROSTRUCTURE AT THE OCEAN FLOOR ...Heat Flow Measurements, Instrumental Services, Oregon, Physical Properties, Technique Development, ...1.0188
EVALUATION OF LOW LEVEL TEMPERATURE GRADIENTS OVER THE LINE ISLANDS NEAR THE EQUATOR ...Atmosphere Radiation, Line Islands, Radiation Balance, ...1.0180
AIRBORNE SEA SURFACE MEASUREMENTS IN THE EQUATORIAL PACIFIC ...Atolls, Humidity, Infrared Radiation, Mapping, Oceanic Fronts, Radiation Detection, ...1.0190
ZONATION OF THE WEDDELL SEA BENTHOS ...Benthic Organisms (non-specif), Environmental Ecology, Marine Biology (non-specific), Weddell Sea, ...5.0868
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ANTARCTIC PHYSICAL OCEANOGRAPHY ...Antarctic Ocean, Currents-ocean, Depth, Photography, Salinity, ...4.0133
INTERACTIONS BETWEEN TURBULENCE, CLOUDS, SEA TEMPERATURE ...Data Analysis - General, Indian Ocean-general, Line Islands, Patterns, Turbulence, ...3.0025

OCEAN BOTTOM EMPLACED GEOPHYSICAL STATION ...Automatic Stations, Benthonic-bottom, Dynamic Gravimeters, Geophysical Equipment, Gravity Studies, Instrumental Services, Pacific Ocean-east, Water Motion Recorders, ...4.0035

HEAT FLOW MEASUREMENTS ...Basins, Heat Flow Measurements, Melanesia, Philippines, Ridges, ...7.0100

THE OPTICAL PROPERTIES OF SEA WATER AND THEIR USE IN OCEANOGRAPHIC RESEARCH & DEVELOPMENT ...Attenuation, Oceanic Fronts, Optical, Oregon, Salinity, Suspension, ...2.0091

DIRECT AND INDIRECT DETERMINATION OF OCEANIC WATER MASS MOTION ON ALL SCALES ...Buoys, Currents-ocean, Oceanic Fronts, Pacific Ocean-east, Salinity, ...2.0092

DETERMINATION OF EQUATION OF STATE, VISCOSITY AND COMPRESSIBILITY OF SEA WATER ...Acoustical, Currents-other, Density, Instrumentation-general, Salinity, Viscosity, ...1.0145

GEOTHERMAL INVESTIGATIONS IN OCEAN REGIONS ...Atlantic Ocean-general, Heat Flow Measurements, Oceanic - Pelagic, Ridges, Sediments-other, ...7.0123

DISTRIBUTIONS OF CURRENTS AND PHYSICAL PROPERTIES WITHIN THE ARCTIC OCEAN ...Acoustical, Arctic Ocean, Currents-ocean, Heat and Radiation Transfer, Sea Ice, ...4.0051

AIR-SEA EXCHANGE ...Albedo, Heat and Radiation Transfer, Infrared Radiation, Massachusetts, Towers, ...3.0026

FINE STRUCTURE FEATURES OF TEMPERATURE AND SALINITY AT WATER MASS BOUNDARIES IN PACIFIC ...Circulation-general, Mixing, Oceanic Fronts, Pacific Ocean-north, Salinity, ...2.0046

FIELD DETECTION AND MEASUREMENT OF INTERNAL WAVES ...Acoustical, Density, Digital Computer Applications, Tides, Waves-internal, ...2.0125

OCEAN DYNAMICS EXPERIMENTS ...Buoys, Moorings, Other-design-and-construction, Submersibles, Technique Development, Water Motion Recorders, ...2.0072

LARGE-SCALE INTERACTIONS ...Acoustical, Air-sea Boundary-general, Buoys, Pacific Ocean-north, Thermal, ...3.0006

OCEANOGRAPHIC RESEARCH ...Acoustical, Forecasting-prediction, Submersibles, ...1.0161

REMOTE SENSING ...Currents-ocean, Gases, Microwave Radiation, Mixing, Oil, Salinity, ...4.0171

REMOTE SENSOR OCEANOGRAPHY ...Aerial Photography, Cloud Temperature, Gulf of Mexico, Infrared Radiation, Satellites, Surface Environments, ...4.0170

BIOGRAPHIC STUDY OF THE BENTHOS OF PUERTO RICO AND THE VIRGIN ISLANDS ...Benthic Fauna, Benthic Flora, Benthonic-bottom, Currents-ocean, Range Or Territorial Distr. , Vertical Distribution, ...5.0652

WOODS HOLE ENVIRONMENTAL STUDIES IN PHYSICAL OCEANOGRAPHY ...Acoustical, Bathythermographs, Oceanic Fronts, Salinity, Velocity, ...1.0056

CHEMICAL AND PHYSICAL DATA ...Fish -non-specific, Population Dynamics, Turbidity & Suspended Matter, Water Movement, Currents,, Water Salinity, Water Temperature-non-specific, ...5.0207

BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SALT MARSH ENVIRONMENT -...Identification, Marine Bacteria, Microbiological Analysis, Salinity, Swamps-marshes, ...5.0762

BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SALT MARSH ENVIRONMENT -...Aquatic Soils, Core Analysis, Identification, Marine Bacteria, Salinity, Swamps-marshes, Water Level Fluctuation, ...5.0763

WINTER DISTRIBUTION OF FISHES ...Continental Shelf, Environmental Ecology, Fish -non-specific, Salinity, Temporal Distribution, Winter, ...5.0153

INVESTIGATION OF THE CIRCULATION OF LAKE SUPERIOR ...Circulation-general, Lake Superior, Model Studies, Stratified Flow, Thermodynamics, Water Motion, ...2.0048

PACIFIC OCEAN INFLUENCE UPON CALIFORNIA RAINFALL ...California, Forecasting, Pacific Ocean-general, Patterns, Rain-other, ...3.0057

VERTICAL CURRENT STRUCTURE IN THE GREAT LAKES ...Circulation-general, Great Lakes-general, ...2.0033

MONTVILLE STATION TEMPERATURE SURVEY (THAMES RIVER) ...British Isles, Electric Power Plants, Estuaries, Maps-other, Thermal Pollution, ...1.0182

HYDROGRAPHY OF APPALACHEE BAY ...Bays, Currents-ocean, Rain-general, Salinity, Sunshine, ...1.0147

DIGITAL RECORDING AND PROCESSING OF IN SITU DEPTH-TEMPERATURE-SALINITY DATA ...Bathythermographs, Depth, Error Analysis, Research - Development, Salinity, ...4.0025

MEASURING PAST OCEANOGRAPHIC CONDITIONS ...Internal Structure, Paleoenvironments, Paleontology, Salinity, Tracers, ...7.0180

OCEANOGRAPHIC SURVEY OF CONTINENTAL SHELF WATERS OFF CHESAPEAKE BAY ...Chesapeake Bay, Continental Shelf, Marine Biology, Salinity, ...4.0135

RELATIONSHIP BETWEEN WATER TEMPERATURE AND SIZE OF PARASITIC COPEPODS ...Collections, Copepods, Host Specificity, Size, Water Temperature-non-specific, ...5.0390

OCEAN DYNAMICS - OCEANOGRAPHIC ANALYSES AND FORECASTING MODELS ...Acoustical, Air-sea Boundary-general, Hydrodynamics, Model Studies, Surface Environments, ...1.0004

OCEANOGRAPHIC RESEARCH ...Acoustical, Anti-submarine-warfare, California, Military Aspects, Transmission, ...1.0005

OCEANOGRAPHIC RESEARCH - INVESTIGATIONS WITH THERMISTOR CHAIN ...Acoustical, Forecasting-prediction, Thermal, Transmission, Water Properties-general, Waves-internal, ...1.0143

PHYSICAL OCEANOGRAPHY ...Surface Environments, Transmission, Velocity, Waves, ...1.0026

OCEAN CURRENTS AND CIRCULATION ...Circulation-general, Currents-ocean, Data Acquisition, Energy, Model Studies, ...2.0015

GREAT LAKES RESEARCH - MONITORING OF WATER CHARACTERISTICS ...Data Acquisition, Forecasting-prediction, Geophysical Analysis, Great Lakes-general, Instrumentation-general, ...1.0185

REMOTE SENSING, GULF COASTAL AREA, CENTRAL FLORIDA ...Aircraft, Aquifers, Fresh Water, Saline Water Systems, Tides, ...4.0160

EFFECT OF TEMPERATURES AND CIRCULATION OF CONTINENTAL SHELF WATERS ON THE DISTRIBUTION OF FISHES ...Continental Shelf, Fish -non-specific, Surface Environments, Water Movement, Currents,, Water Temperature-non-specific, ...4.0165

PACIFIC COASTAL ENVIRONMENT AS RELATED TO DISTRIBUTION AND ABUNDANCE OF GAME SPECIES -- SEA SURFACE TEMPERATURE MEASUREMENTS ...Aquatic Ecology, California, Spectral Reflectance, ...1.0175

HISTORICAL CHARTS AND INTERPRETATION OF CHANGES IN SEA SURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN ...Air-sea Boundary-general, Atlases-maps, Circulation-general, Commercial Fishing, Pacific Ocean-north, ...1.0179

STUDY ASSOCIATION BETWEEN TRADE WIND SYSTEM AND NORTH PACIFIC OCENAOGRAPHIC CLIMATE ...Hawaii, Meteorological Studies, Ocean-lakes, Waves, Wind-water Interaction, ...3.0019

INVESTIGATE SEASONAL VARIATIONS, SURFACE WATER TYPES, HAWAIIAN AREA (KOKO HEAD) ...Commercial Fishing, Hawaii, Heat and Radiation Transfer, Oceanic Fronts, Salinity, Tuna, Mackerel, Albacore... , Water Salinity, Water Temperature-non-specific, ...1.0148

THE EFFECTS OF ENVIRONMENTAL CONDITIONS ON THE SPAWNING AND SURVIVAL OF FRY OF THE WALLEYE ...Environmental Effects-geologic, Eutrophication, Lake Erie, Pollution - Effects of , Walleyes, ...5.0299

MONITORING SURVEY AND TIME-SERIES ANALYSIS OF SUBSURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN ...Pacific Ocean-north, Subsurface Environments, Thermocline, Water Temperature-non-specific, ...1.0176

OPERATIONAL EVALUATION OF NSRT SYSTEM ...Equipment, Special Mission Ships, Surface Environments, ...8.0059

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION SUBARTIC OCEANOGRAPHY ...Currents-ocean, Depth, Pacific Ocean-north, Range Or Territorial Distr. , Salinity, Salmon -coho,chinook,sockeye.., ...1.0159

PREDICTION OF ENVIRONMENT ...Biological-general, Columbia River, Environmental Ecology, Low Temp. -but Above 32f, Physical-general, Reservoirs and Impoundments, Salmon & Trout - Non-specific, Snake River, Thermal Pollution, ...5.0225

ZOOPLANKTON DISTRIBUTION IN THE TROPICAL ATLANTIC ...Atlantic Ocean-general, Plankton Sampling, Range Or Territorial Distr. , Tropic, Vertical Distribution, Zooplankton, ...5.0771

FISHERY FORECASTING - TEMPERATE FISHERIES ...Circulation-general, General Synoptic Observations, Low Temp. -but Above 32f, Pacific Ocean-east, ...5.0197

SCRIPPS TUNA OCEANOGRAPHY RESEARCH PROGRAM ...Food Supply, Pacific Ocean-east, Tropic, Tuna, Mackerel, Albacore... , Water Temperature-non-specific, ...5.0200

FIELD STUDY - CAPE COD, MASS. ...Animal Distr. (non-specific), Benthonic-bottom, Buoys, Environmental Ecology, Sediments-other, ...5.0584

STANDARD MONITORING SECTIONS (ATLANTIC AND PACIFIC OCEAN) ...California Current, Kuroshio Current, Labrador Current, Platforms, Salinity, ...4.0004

TIME-SERIES OBSERVATIONS OF TEMPERATURE AND SALINITY (NORTH ATLANTIC AND NORTH PACIFIC OCEAN STATIONS) ...Atlantic Ocean-north, Depth, Pacific Ocean-north, Salinity, Sampling, ...4.0005

OCEANOGRAPHIC STUDY OF NORTHEASTERN U. S. COASTAL WATERS FOR INTERNATIONAL COMMISSION FOR NORTHWEST ATLANTIC FISHERIES ...Commercial Fishing, Gases, Salinity, Ships and Cruises, ...4.0123

AERIAL SEA SURFACE TEMPERATURE SURVEYS OF U S. COASTAL WATERS ...Aircraft, Infrared Radiation, Migration, Productivity - Food Chain, Water Temperature-non-specific, ...4.0148

BARBADOS OCEANOGRAPHIC AND METEOROLOGICAL EXPERIMENT ...British West Indies, Depth, Ocean-lakes, Salinity, Wind-water Interaction, ...3.0015

Thermal

EFFECTS OF THERMAL MICROSTRUCTURE ON ACOUSTIC TELEMETRY ...Acoustical, Currents-other, ...1.0066

DEVELOPMENT OF PHYSICAL-NUMERICAL MODELS FOR STUDIES OF THE ATMOSPHERE-OCEAN PLANETARY BOUNDARY LAYER ...Advection, Mixing, Simulation Theory, Turbulence, Wind-water Interaction, ...3.0010

FISHERIES OCEANOGRAPHY AND ENVIRONMENTAL ASSESSMENT AND PREDICTION ...Commercial Fishing, Convection, Oceanography-general, Spacecraft Sensory Devices, ...4.0150

DEPOSITION RATES BY THE PROTACTINIUM METHOD ...Chemical, Distribution, Element Ratios, Manganese, Sedimentary Petrogenesis, Thorium, Uranium, ...7.0270

OCEAN WAVES AND TIDES ...Currents-ocean, Subsurface Environments, Tides, Water Motion Recorders, Waves, ...2.0080

AIR/SEA INTERACTION STUDY ...Convection, Mixing, Profiles, Thermocline, Waves, ...2.0114

AIR-SEA INTERACTION ...Air-sea Boundary-general, Currents-ocean, Gulf of Mexico, Tropical Cyclones, Weather Forecasting, ...3.0042

CONVECTIVE STUDIES ...Convection, Pacific Ocean-north, Sonar, ...2.0011

PHYSICAL OCEANOGRAPHY ...Convection, Hawaii, Heat and Radiation Transfer, Mixing, Wind-water Interaction, ...3.0034

PROPERTIES OF SEA WATER ...Compressibility--gas-liq, Conductivity, Density, Electrical, Expansion, Physical Analysis, ...1.0153

WAVES ...Pacific Ocean-north, Waves, Waves-internal, ...2.0097

MICROSTRATIFICATION OF MARINE ZOOPLANKTON ...Environmental Physiology, Growth Rate, Vertical Distribution, Zooplankton, ...5.0753

THE CONTRIBUTION OF ADVECTION AND LOCAL HEATING TO THE MAINTENANCE OF THE THERMAL STRUCTURE IN THE NORTH PACIFIC OCEAN ...Circulation-general, Convection, Heat and Radiation Transfer, Mixing, Pacific Ocean-north, ...1.0183

RESEARCH IN AIR-ENERGY EXCHANGE ...Heat and Radiation Transfer, Lasers and Masers, Optical, Visible, ...3.0035

DYNAMICAL OCEANOGRAPHY AND GEOPHYSICAL FLUID DYNAMICS ...Acoustic Effects, Circulation-general, Forced Convection, Theoretical Analysis, Water Tunnels Tables, ...2.0012

STABLE ISOTOPE STUDIES ON COEXISTING MINERALS IN MARINE SEDIMENTS ...Coring and Dredging, Diagenesis, Genetic Relationships, Mineralogy, Red Sea, Salinity, ...1.0106

GEOPHYSICAL AND GEOCHEMICAL STUDY OF RED SEA MINERAL DEPOSITS ...Coring and Dredging, Gulf of Aden, Igneous Activity - Volcanism, Mineralogy, Red Sea, ...7.0023

AIR-SEA INTERACTION ...Forecasting-prediction, Heat and Radiation Transfer, Meteorological Studies, Wind-water Interaction, ...3.0023

OCEANIC INTERNAL MOTIONS AFFECTING OPERATIONS ...Bermuda, Buoys, Military Aspects, Water Motion Recorders, Waves-internal, ...2.0115

OCEAN DYNAMICS EXPERIMENTS ...Atlantic Ocean-north, Buoys, Currents-ocean, Operational Aspect, Waves-internal, ...2.0071

TURBULENT PROCESSES AT AIR-SEA AND BOTTOM BOUNDARIES OF THE OCEAN ...Currents-bottom, Turbulence, Waves, Wind-water Interaction, ...3.0033

RADIANT ENERGY FLUX ACROSS THE AIR-SEA INTERFACE AND HEAT BUDGET OF THE OCEANS ...Air-sea Boundary-general, Forecasting-prediction, Heat and Radiation Transfer, Heat Exchange, Radiation-general, ...3.0032

TURBULENCE OVER WAVES ...Forecasting-prediction, Heat and Radiation Transfer, Heat Exchange, Meteorological Studies, Turbulence, Waves, ...3.0027

LARGE-SCALE INTERACTIONS ...Acoustical, Air-sea Boundary-general, Buoys, Pacific Ocean-north, Temperature, ...3.0006

INTERNAL WAVE STUDY ...Acoustical, Atlantic Ocean-north, Continental Shelf, Tides, Waves-internal, ...2.0099

THERMAL PROPERTIES OF SEA WATER AT LOW TEMPERATURE AND HIGH PRESSURE ...Acoustical, Conduction, Expansion, Hydrodynamics, Physical Analysis, ...1.0177

CIRCULATION STUDIES ...Circulation-general, Currents-ocean, Gulf of Mexico, Model Studies, Tropical Cyclones, ...2.0044

THERMAL WAKE STUDIES ...Physical Analysis, Thermocline, Turbulence - Sea Water, Waves-internal, ...1.0174

A STUDY OF THE ICHTHYOPLANKTON ASSOCIATED WITH TWO OF NEW JERSEYS COASTAL INLETS ...Estuaries, Nets, Salinity, Water Salinity, Water Temperature-non-specific, Zooplankton, ...5.0806

CHEMICAL RESPONSES BY MARINE ORGANISMS TO STRESS ...Environmental Changes, Environmental Ecology, Environmental Physiology, Protein, Salinity, ...5.1026

OCEANOGRAPHIC RESEARCH ...Acoustical, Density, Gases, Marine Biology, Water Motion, ...1.0142

PHYSIOCHEMICAL AND ACOUSTIC PROPERTIES OF SEA WATER ...Acoustical, Electrical, Saline Water Systems, Solution, ...1.0157

SHALLOW WATER ACOUSTIC PROPAGATION STUDIES (SWAPS) ...Acoustical, Geomorphology-topography, Liquids, Subbottom, Transmission, Turbulence - Sea Water, Water Motion, Waves, ...1.0065

OCEANOGRAPHIC RESEARCH - INVESTIGATIONS WITH THERMISTOR CHAIN ...Acoustical, Forecasting-prediction, Temperature, Transmission, Water Properties-general, Waves-internal, ...1.0143

OCEANOGRAPHIC RESEARCH-INVESTIGATIONS IN SHALLOW WATER ...Acoustical, Environmental Effects-geologic, Model Studies, Salinity, Water Motion, ...1.0009

PHYSICAL PROPERTIES OF SEA WATER AT PRESSURE ...Heat Exchangers, Pressure, Viscosity, ...1.0149

TEMPERATURE TOLERANCE OF MARINE ANIMALS THROUGH BEHAVORAL RESPONSES ...Behavior, Environment Resistance, Mortality Rates, Water Temperature-non-specific, ...5.0118

THERMAL PREFERENCES OF MARINE FISHES AND INVERTEBRATES ...Behavior, Fish -non-specific, Invertebrates - non-specific, Water Temperature-non-specific, ...5.0209

EFFECTS OF HOT WATER MASSES ON MARINE FISHES ...Atlantic Ocean-north, Behavior, Fish -non-specific, High Temp. -85f Or Above Oceanic Fronts, ...5.0210

ANALYZE AND PUBLISH BASIC DATA FROM PILOT STUDY ...Environmental Changes, Oceanic Fronts, Pacific Ocean-general, Salinity, Technique Development, ...4.0024

Thermocline

AIR/SEA INTERACTION STUDY ...Convection, Mixing, Profiles, Thermal, Waves, ...2.0114

EXPERIMENTAL HYDRODYNAMICS ...Fluid Dynamics, Heat and Radiation Transfer, Hydrodynamics, Simulation Theory, Submersibles, ...8.0192

OCEAN WAVES AND STRUCTURE ...Buoys, Salinity, Tides, Water Motion Recorders, Waves, ...2.0106

THERMAL WAKE STUDIES ...Physical Analysis, Thermal, Turbulence - Sea Water, Waves-internal, ...1.0174

MONITORING SURVEY AND TIME-SERIES ANALYSIS OF SUBSURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN ...Pacific Ocean-north, Subsurface Environments, Temperature, Water Temperature-non-specific, ...1.0176

Thermodynamics

MARINE GEOCHEMISTRY RESEARCH ...Depth, Gases, Mineral Genesis, Mineralogy, Radioactive Dating, Sedimentation, ...7.0055

A STUDY OF THE TEMPERATURE MICROSTRUCTURE AND EDDY TRANSPORT IN THE OCEAN FLOOR BOUNDARY LAYER ...Benthonic-bottom, Geothermal, Heat Flow Measurements, Physical Analysis, Temperature, ...1.0189

CIRCULATION AROUND OCEANIC ISLANDS ...Circulation-general, Density, Islands, Mixing, Waves-internal, Wind-water Interaction, ...2.0010

RESEARCH IN OCEANIC PHYSICS ...Atlantic Ocean-south, Convection, Mixing, Oceanic Fronts, Wind-water Interaction, ...2.0059

PHYSICAL OCEANOGRPAHY IN OREGON SHELF AND SLOPE WATERS ...Continental Shelf, Continental Slope, Hydrodynamics, Mixing, Oregon, ...2.0076

THE INSTITUTE FOR THE DEVELOPMENT OF RIVERINE AND ESTUARINE SYSTEMS (IDRES) ...Delaware River, Estuaries, Waste Disposal-general, ...12.0043

INVESTIGATION OF THE CIRCULATION OF LAKE SUPERIOR ...Circulation-general, Lake Superior, Model Studies, Stratified Flow, Temperature, Water Motion, ...2.0048

CIRCULATION DYNAMICS (GULF OCEANOGRAPHY PROGRAM) ...Circulation-general, Environmental Changes, Gulf of Mexico, Shrimps - Common, ...2.0045

Viscosity

DETERMINATION OF EQUATION OF STATE, VISCOSITY AND COMPRESSIBILITY OF SEA WATER ...Acoustical, Currents-other, Density, Instrumentation-general, Salinity, Temperature, ...1.0145

PHYSICAL PROPERTIES OF SEA WATER AT PRESSURE ...Heat Exchangers, Pressure, Thermal, ...1.0149

Water Properties-general

CIRCULATION STUDIES ...Acoustical, Caribbean Sea, Dispersion, Ocean Currents-other, Transmission, ...1.0046

THE ECOLOGY OF COCCOLITHOPHORIDACEAE IN THE ATLANTIC COASTAL WATERS OF THE UNITED STATES ...Atlantic Ocean-general, Continental Shelf, ...5.0841

INTERNATIONAL INDIAN CEAN EXPEDITION PHYSICAL AND CHEMICAL ATLAS ...Data & Statistics Storage, Data Analysis - General, General Sea Water Chemistry, Indian Ocean-general, Tables, Compilations, Catalogs, ...4.0130

PHYSICAL AND CHEMICAL PROPERTIES OF THE SHELF AND SLOPE WATERS OFF NORTH CAROLINA ...Atlantic Ocean-north, Continental Shelf, General Sea Water Chemistry, North Carolina, Oceanic Fronts, ...1.0156

PHYSICAL AND CHEMICAL ATLAS ...Atlases-maps, Convection, General Sea Water Chemistry, Indian Ocean-general, Water Analysis-general, ...4.0026

SUPPORT OF TWO RESEARCH VESSELS ...Air-sea Boundary-general, General Sea Water Chemistry, Great Lakes-general, Marine Biology, Ships and Cruises, ...12.0034

OCEAN ENGINEERING RESEARCH ...Alloys, Engineering Studies-general, Materials Used Undersea, Moorings, Water, ...8.0050

OCEANOGRAPHIC PROCESSES IN ESTUARINE AND COASTAL WATERS ...Oceanic Fronts, Pacific Ocean-east, Puget Sound, Shoreline - Coastline, Washington, ...4.0050

AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE ...Management, Nitrate, Nitrite, Phosphate, Phosphite, Swamps-marshes, Tidewater Areas, ...5.0953

DETERMINATION OF SAFE LEVELS OF POLLUTION IN PUERTO RICO ...Bays, Contamination - Water, Meteorological Studies-general, Pollution - Effects of , Puerto Rico, Recreation Sites, ...6.0181

OCEANOGRAPHIC RESEARCH - INVESTIGATIONS WITH THERMISTOR CHAIN ...Acoustical, Forecasting-prediction, Temperature, Thermal, Transmission, Waves-internal, ...1.0143

SHALLOW WATER PROPAGATION ...Acoustical, Coherence, Reverberation, Shoals, Transmission, ...1.0035

UNDERWATER ACOUSTIC ANALYSIS ...Acoustical, Forecasting-prediction, Phase Relationships, Signal Analysis-other, Transmission, ...1.0038

REVERBERATION RESEARCH STUDIES ...Acoustical, Liquids, Reverberation, ...1.0027

ENVIRONMENTAL SUPPORT OF SONAR DESIGN ...Acoustical, Liquids, Model Studies, Ships and Cruises, Transmission, ...1.0015

UNDERWATER SOUND PROPAGATION STUDIES ...Acoustical, Attenuation, Liquids, Transmission, ...1.0029

GREAT LAKES RESEARCH - SPOIL DISPOSAL EFFECTS ...Dispersion -water, Great Lakes-general, Pollution - Effects of , Sediments, Spoil Banks, Suspension, ...6.0157

EFFECTS OF HEATED WATER IN A TIDAL ESTUARY ...Chesapeake Bay, Electric Power Plants, Pollution - Effects of , Pollution Effects, Thermal Pollution, Tidal Streams, ...6.0145

REMOTE SENSING, EVERGLADES AREA, FLORIDA ...Computer Applications, Florida, Remote Areas, Swamps-marshes, Visible Light, ...4.0161

COASTAL AND INSHORE OCEANOGRAPHY ...Alaska, Estuaries, Marine Biology, Shoreline - Coastline, Water Analysis-general, ...5.0851

BIOASSAY ...Animal Pollutant Sources, Evaluation, Lampreys, Piscicides -non-specific, Streams, ...5.0632

PILOT STUDY OF LIMITED PORTION OF TRADE WIND ZONE OCEANOGRAPHY (DATA AND DESCRIPTIVE REPORTS) ...Environmental Changes, Oceanic Fronts, Pacific Ocean-north, Technique Development, ...4.0129

PINK SALMON INVESTIGATIONS - FRESHWATER ECOLOGY ...Alaska, Aquatic Ecology, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, Streams, ...5.0185

SEA SURFACE SURVEILLANCE ...Caribbean Sea, Circulation-general, Temporal Distribution, Tuna, Mackerel, Albacore... , Vertical Distribution, ...2.0019

ARCTIC EAST OCEANOGRAPHIC PROJECT (OCEANOGRAPHY OF THE BAFFIN BAY REGION) ...Baffin Bay, Circulation-general, Marine Biology, Polar, Sea Water Chemistry-other, ...4.0125

Water Quality Control

Adsorption

RELATIONSHIP BETWEEN GLACIAL FLOUR POLLUTION AND POLLUTANTS FROM OTHER SOURCES ...Adsorption Capacity, Alaska, Estuaries, Glacial Clastics, Pollution - Effects of , Pulp, Paper , and Logging, Size, ...6.0134

Desalination

BRACKISH WATER PURIFICATION BY BIOLOGICAL FUEL CELL POWERED ELECTRODIALYSIS ...Biological, Brackish Water, Desalination Wastes, Electrodialysis, Material Recovery Wastes, Water Costs, ...6.0161

A UNIFIED APPROACH TO WATER, FOOD AND POWER IN A COASTAL DESERT COMMUNITY ...Arid and Desert, Deserts, Diesel, Distilling Units, Electric Power Plants, Greenhouse, Use of Impaired Water, ...7.0002

Flow Augmentation

TRACERS STUDIES IN ALASKAN HARBORS ...Estuaries, Harbors, Industrial Wastes, Tides, Tracers-general, ...2.0049

Pollution Abatement

PUBLIC INVESTMENT CRITERIA FOR WATER-ORIENTED RECREATION IN THE LAKE ERIE BASIN ...Alternative Planning, Costs, Finance, Fiscal, Projected Demand, Recreation Sites, ...9.0016

DELAWARE ESTUARY AND BAY WATER QUALITY SAMPLING AND MATHEMATICAL MODELING PROJECT ...Data Analysis - General, Delaware Bay, Mathematical Analysis, Model Studies, Technique Development, ...6.0163

FATE OF INLAND DERIVED POLLUTANTS IN AN ESTUARY ...Estuaries, Pollutants - Path of , Pollution - Effects of , Pollution Sources-general, Systems Analysis, ...6.0133

Self-purification

COLUMBIA RIVER SEDIMENT STUDIES ...Columbia River, Geochemical Analysis, Radioactivity-general, Radiochemical Analysis, Sediments, ...6.0190

STUDIES ON INORGANIC NUTRIENT ASSIMILATION RATES IN ESTUARINE PONDS ...Estuaries, Mineral Content -water, Nitrogen, Nutrients, Phosphorus, ...5.0991

Stream Rehabilitation

RESTORATION AND REHABILITATION OF EARTHQUAKE DAMAGED PINK AND CHUM SALMON STUDIES IN PRINCE WILLIAM SOUND ...Alaska, Earthquakes, Flow Characteristics -water, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, Tectonics-general, ...5.0191

Waste Water Treatment-general

GALVESTON BAY STUDY ...Estuaries, Numerical Analysis-other, Optimization, Simulation, Tides, ...4.0062

MICROBIOLOGY OF ESTUARINE AND SHELLFISH POLLUTION ...Bioindicators, Clams, Estuaries, Oysters, Pollution Effects, Sanitation, ...6.0162

Water Quality Control-general

A STOCHASTIC MODEL FOR POLLUTION IN ESTUARIES ...Estuaries, Ions and Gases, Model Studies, Oxygen, Water Quality-general, ...6.0188

AN ECONOMIC EVALUATION OF WATER POLLUTION CONTROL, YAQUINA BAY, ORE ...Alternative Planning, Bays, Benefit-cost Analysis, Model Studies, Oregon, Systems Analysis, ...6.0173

SOCIO-ECONOMIC STUDY OF NARRAGANSETT BAY, RHODE ISLAND ...Bays, Benefit-cost Analysis, Estuaries, Land Use, Rhode Island, Social Aspects, ...9.0019

Water Quality-general

CRITERIA FOR EVALUATING THE QUALITY OF WATER BASED RECREATION FACILITIES ...Boating, Fishing, Marinas, Standards, Swimming, User Characteristics, ...9.0015

WATER QUALITY AS RELATED TO SURVIVAL OF SALMON EGGS AND LARVAE ...Environmental Ecology, Mortality Rates, Reproduction Studies (general), Salmon & Trout - Non-specific, Spawning & Nesting Sites, ...5.0227

ENHANCEMENT OF RECREATIONAL USES OF ESTUARINE WATERS THROUGH STUDY OF POTENTIAL CONTROL METHODS FOR STINGING SEA NETTLES ...Biological Control, Chesapeake Bay, Estuaries, Jelly Fish, Recreation Sites, ...5.0605

HORIZONTAL DISPERSION IN SHALLOW ESTUARIES OF IRREGULAR SHAPE ...Circulation -water, Dispersion -water, Estuaries, Gulf of Mexico, Model Studies, ...2.0064

SURFACE AND GROUND WATER POTENTIALITIES OF THE MULLICA RIVER BASIN ...Aqueducts, Conjunctive Use, Economic Impact, Estuaries, Systems Analysis, Water Transfer, ...9.0014

ECONOMICS OF WATER QUALITY FOR A REGIONAL SYSTEM ...Delaware River, Economic Efficiency, Estuaries, Finance, Regional Areas, Water Demand, ...9.0018

EFFECTS OF RIVERS ON THE METABOLISM OF TEXAS BAYS ...Bays, Nutrients, Pollutants-general, Primary Productivity, Streams, Texas, ...6.0187

A STOCHASTIC MODEL FOR POLLUTION IN ESTUARIES ...Estuaries, Ions and Gases, Model Studies, Oxygen, Water Quality Control-general, ...6.0188

POLLUTION STUDY OF THE VENICE DISTRICT CANAL ...California, Canals, Model Studies, Synthetic Hydrology, ...6.0141

GREAT LAKES RESEARCH - CHARACTERISTICS OF LAKE WATER ...Chemical-general, Great Lakes-general, Meteorological Studies, Ocean Currents-other, Physical-general, ...1.0154

WATER QUALITY AND NUTRIENTS, SACRAMENTO-SAN JOAQUIN RIVER SYSTEM ...Environmental Ecology, Eutrophication, Fish -non-specific, Nutrients, Plankton (non-specific), ...6.0139

HYDROLOGY OF COASTAL AREA IN THE VICINITY OF RICEBORO, GEORGIA ...Aquifers, Artesian Flow, Dispersion - water, Estuaries, Georgia, Saline Water Intrusion, ...9.0007

TIDAL DISCHARGE RESEARCH, NEW JERSEY ...Data Acquisition, Data Reduction and Analysis, Discharge, Sediments, Tides, ...2.0088

HYDROLOGY OF UPPER OLD TAMPA BAY, FLORIDA ...Bays, Groundwater Movement, Hydrology-general, Lakes, Permeability, Water Harvesting, ...2.0067

CHEMICAL CHARACTERISTICS OF THE GREAT LAKES ...Chemical Analysis (water), Great Lakes-general, Nutrients, Productivity - Food Chain, ...1.0116

RESEARCH ON THE MACROBENTHOS OF THE GREAT LAKES ...Aquatic Ecology, Benthic Fauna, Earthworms, Food Supply, Great Lakes-general, ...5.0626

GROWTH, CONDITION, AND SURVIVAL OF SHELLFISH ...Adaptation, Environmental Physiology, Maryland, Oysters, Water Salinity, ...5.0447

PLANKTON REARING, ENVIRONMENTAL REQUIREMENTS AND SENSITIVITY STUDIES ...Algal Culture, Bioindicators, Great Lakes-general, Microbiological Analysis, Plankton (non-specific), ...5.0804

Water Resources Development

AN APPROACH TO MARINE RESOURCE DEVELOPMENT IN ALASKA ...Alaska, Marine Biology (non-specific), Planning, ...7.0001

Water Storage

HYDROLOGIC SYSTEMS ANALYSIS OF THE GREAT LAKES ...Discharge, Great Lakes-general, Inflow, ...4.0076

CONSTRUCTION OF A FACILITY TO DEMONSTRATE OFF-SHORE UNDERWATER TEMPORARY STORAGE OF STORM OVERFLOW FROM A COMBINATION SEWER ...Combined Sewer, Elastomers, Rubber, Lake Erie, Storm Water, Tank, Pressure Vessel, ...8.0328

Water Supply-general

INTERSTITIAL WATER OF GLACIAL-MARINE SEDIMENT ...Alaska, Estuaries, Glacial Clastics, Interstitial - Connate Water, Water, ...7.0188

Water Transfer

SURFACE AND GROUND WATER POTENTIALITIES OF THE MULLICA RIVER BASIN ...Aqueducts, Conjunctive Use, Economic Impact, Estuaries, Systems Analysis, Water Quality-general, ...9.0014

Water Utilization -domestic

EFFECTS OF WATER POLLUTION IN SAN FRANCISCO BAY ...Bays, Economic Impact, Pollution - Effects of , Recreation Sites, San Francisco Bay, Social Aspects, Welfare Economics, ...6.0140

Water Utilization -general

EXTENT OF BRACKISH WATER IN TIDAL RIVERS, MARYLAND ...Brackish Water, Runoff, Tides, ...1.0100

Watersheds

AN OPTICAL METHOD OF MEASURING THE FORM OF THE FREE SURFACE OF A FLUID ...Fluid Dynamics, Free Surface Waves, Models, Optical, Optical Systems, Waves, ...2.0124

Waves

WAVE DAMPING SYSTEMS ...Breakwaters, Energy Dissipators, Model Studies, Shoreline Structures, Wave Action, ...8.0047

PREDICTION OF EXTREME ENVIRONMENTAL FACTORS ...Forecasting-prediction, Meteorological Extremes, Statistics-general, Technique Development, Wind-general, ...4.0048

TROPICAL STORM INVESTIGATIONS IN THE ATLANTIC, CARIBBEAN, AND GULF OF MEXICO ...Meteorological Studies, Satellites, Tropic, Tropical Cyclones, Vorticity, ...3.0048

FULL SCALE STRESS MEASUREMENT TESTS OF GREAT LAKES ORE CARRIER ...Great Lakes-general, Hull, Other-design-and-construction, Testing Structural, ...8.0320

SEAKEEPING QUALITIES - MOTIONS AND POWERING PREDICTIONS ...Merchant-ships, Safety, Ship Resistance Stability, ...8.0306

WATER WAVE DOCUMENTATION ...Buoys, California, Pacific Ocean-general, Water Motion Recorders, ...2.0094

THEORETICAL ACOUSTIC-GRAVITY WAVE PROPAGATION ...Earthquake Location, Earthquakes, Energy Exchange Processes, Nuclear Devices, ...2.0126

AMBIENT SEA NOISE INVESTIGATION ...Acoustic, Acoustical, Computer Applications, Noise, Wind-water Interaction, ...1.0048

KINEMATICS OF SEDIMENTS IN BREAKERS ...Coastal Engineering-other, Development, Hydrodynamics, Sedimentation, Suspension, ...7.0237

LONG PERIOD WAVES ...Fjords, Hydrodynamics, Iceland, Seiches, Tides, ...2.0108

HIGH FREQUENCY OCEAN WAVES ...Aircraft, Forecasting-prediction, Photogrammetry, Radar, Wind-water Interaction, ...2.0121

OCEAN WAVES AND TIDES ...Currents-ocean, Subsurface Environments, Thermal, Tides, Water Motion Recorders, ...2.0080

AIR/SEA INTERACTION STUDY ...Convection, Mixing, Profiles, Thermal, Thermocline, ...2.0114

WHITECAPPING ...Meteorological Studies, Particle-gas Transfer, Temperature, Velocity, Wind-water Interaction, ...2.0120

HIGH FREQUENCY WAVES ...Forecasting-prediction, Heat and Radiation Transfer, Hydrodynamics, Water Motion Recorders, ...2.0113

OCEAN WAVES ...Model Studies, Profiles, Temperature, Waves-internal, Wind-water Interaction, ...3.0004

WAVES ...Pacific Ocean-north, Thermal, Waves-internal, ...2.0097

A STUDY OF PROBLEMS RELATED TO WIND-GENERATED WAVES ...Free Surface Waves, Laminar - Turbulent, Theoretical Analysis, Wind-water Interaction, ...4.0088

AN OPTICAL METHOD OF MEASURING THE FORM OF THE FREE SURFACE OF A FLUID ...Fluid Dynamics, Free Surface Waves, Models, Optical, Optical Systems, Watersheds, ...2.0124

WAVE, CURRENT AND STORM SURGE RESPONSE TO EXTREME WIND CONDITIONS ...Currents-ocean, Forecasting-prediction, Model Studies, Storms-general, Wind-water Interaction, ...2.0107

WAVE UPLIFT FORCES ON HORIZONTAL PLATFORMS ...Hydrodynamic Structures, Platforms, Wave Action, ...8.0266

FORCES AND MOTIONS INDUCED BY WAVES ON OCEAN PLATFORMS ...Coastal Engineering-other, Models, Platforms, Wave Action, ...8.0312

PARTIAL DIFFERENTIAL EQUATIONS AND CONTINUUM MECHANICS ...Acoustical, Approximations, Ordinary, Partial, ...8.0171

MARINE HYDRODYNAMICS ...Antarctic Ocean, Circulation-general, Laboratory Analysis, Model Studies, Waves-internal, ...8.0196

EXPERIMENTAL STUDY OF THE INTERRELATIONS BETWEEN WIND-WAVE PROPERTIES ...Hydrodynamics, Mixing, Pressure, Turbulence - Sea Water, Wind-water Interaction, ...2.0123

STUDY OF LOW FREQUENCY SURFACE WAVES IN THE PACIFIC OCEAN ...Meteorological Studies, Sea Level Variations, Tides, Turbulence - Sea Water, Water Motion Recorders, ...2.0068

THEORETICAL STUDIES OF TSUNAMI PROPAGATION ...Depth, Environmental Effects-geologic, Forecasting-prediction, Geomorphology-topography, Tsunami, ...2.0122

TIME FLUCTUATIONS IN OCEAN CURRENTS ...Currents-ocean, Geomorphology-topography, Model Studies, Testing of Models, ...2.0039

METEOROLOGICAL SUPPORT OF DEEP-SEA DRILLING OPERATIONS ...Coring and Dredging, Drilling and Coring, Meteorological Studies, Teaching and Research, Weather Forecasting, ...12.0013

(U) OCEAN CIRCULATION MODELS ...Circulation-general, Currents-ocean, Model Studies, Shear, Wind-water Interaction, ...2.0024

RADAR SCATTERING ...Radar, ...4.0103

DYNAMICS OF MOORED BUOY SYSTEMS USED IN OCEANOGRAPHY R&D AND SURVEILLANCE ...Buoys, Currents-ocean, Laboratory Analysis, Model Studies, Moorings, ...8.0321

THEORETICAL STUDY OF OCEAN TIDES FOR PURPOSES OF WORLDWIDE PREDICTION ...Earth Tides, Forecasting-prediction, Mediterranean Sea-other, Tides, ...2.0090

OCEAN WIND WAVE GENERATION AND DISSIPATION ...Buoys, General Synoptic Observations, North Sea, Velocity, Wind-water Interaction, ...2.0105

WAVE GENERATION BY THE TURBULENT WIND FIELD OVER THE SEA ...Platforms, Pressure-density, Turbulence, Velocity, Wind-water Interaction, ...3.0008

PROPAGATION AND REFRACTION OF OCEAN WAVES IN NEAR SHORE REGIONS ...Forecasting-prediction, Mathematical Analysis, Operational Aspect, Surface Environments, ...2.0117

AIR-SEA INTERACTION (WAVES) ...British West Indies, Forecasting-prediction, Heat and Radiation Transfer, Surface Environments, Wind-water Interaction, ...3.0016

LONG-PERIOD WAVES ...Bermuda, Pressure, Sea Level Variations, Statistics-general, ...2.0085

TURBULENT PROCESSES AT AIR-SEA AND BOTTOM BOUNDARIES OF THE OCEAN ...Currents-bottom, Thermal, Turbulence, Wind-water Interaction, ...3.0033

MODEL STUDIES OF REFRACTION OF SHOALING OCEAN WAVES ...Forecasting-prediction, Model Apparatus-other, Model Studies, Shoals, Wave, ...8.0194

TURBULENCE OVER WAVES ...Forecasting-prediction, Heat and Radiation Transfer, Heat Exchange, Meteorological Studies, Thermal, Turbulence, ...3.0027

OCEAN WAVES AND STRUCTURE ...Buoys, Salinity, Thermocline, Tides, Water Motion Recorders, ...2.0106

NEARSHORE WAVE THEORY ...Development, Model Studies, Sediment Transport-general, Shoreline - Coastline, ...2.0119

CRITERIA FOR THE DESIGN OF SMALL CRAFT HARBORS ...Breakwaters, Coastal Engineering-other, Harbors, Marinas, Seiches, ...8.0036

MEASUREMENT OF SURGING IN KUHIO BAY, HILO HAWAII ...Gaging, Harbors, Hawaii, Tsunami, Water Motion Recorders, ...2.0112

AN ANALYTICAL AND EXPERIMENTAL STUDY OF BED FORMS UNDER WATER WAVES ...Channel Roughness, Friction, Geomorphology-topography, Model Studies, Water Tunnels Tables, Wave Action, ...2.0110

COMPUTER SIMULATION OF THE PROPAGATION OF SURFACE WAVES ...Channel Roughness, Models, Partial, Velocity, Wave Motion in Fluids-other, ...4.0082

WAVE AND SURGE ACTION STUDY FOR LOS ANGELES-LONG BEACH HARBORS ...California, Harbors, Models, Surface Ships, Wave Action, ...2.0098

DESIGN OF RUBBLE WAVE-ABSORBER ...Beaches, Energy Dissipators, Harbors, Measuring Devices-other, Shoreline Structures, ...8.0037

PROJECT EVAPORATION ...Data Analysis - General, Evaporation, Model Studies, Oklahoma, ...3.0031

TRANSVERSAL DRIFTS IN BOTTOM PROFILE ...Bathymetry, Benthonic-bottom, Intertidal Areas, Ocean Waves - Currents, ...7.0224

WAVE MEASUREMENT IN THE OPEN OCEAN ...Buoys, Data Acquisition, Oceanic - Pelagic, Profiles, Water Motion Recorders, ...2.0109

CIVIL ENGINEERING STRUCTURES IN THE OCEANS ...Coastal Engineering-other, Engineering Studies-other, Foundations-general, Model Studies, Soil Dynamics, ...8.0340

WAVE FORCES ON BREAKWATERS ...Breakwaters, Hydrodynamics, Model Studies, Shoreline Structures, Wave Action, ...8.0044

A RECONNAISSANCE OF COASTAL EROSION IN NORTH CAROLINA ...Aerial Photography, Beach, Development, Erosional Features, North Carolina, Photogrammetry, Reconnaissance, Shoreline - Coastline, ...7.0268

FLUID MECHANICS RESEARCH ...Forecasting-prediction, Hydrodynamics, Industrial Engineering, Ship Resistance Stability, ...8.0176

FUNDAMENTAL PROBLEMS IN HYDRODYNAMICS ...Convection, Hydrodynamics, Ordnance, Survey Studies, Waves-internal, ...2.0102

MODEL FOR THE PRELIMINARY DESIGN OF SURFACE EFFECT SHIPS ...Computer Applications, Drag, Hydrofoils Crafts, Marine Propulsion, Other Models, Ships and Cruises, ...8.0279

RADIOACTIVE AEROSOL SCAVENGING BY OCEAN SPRAY ...Aerosols, Nuclear Explosions - Fallout, Radioactivity-general, Strontium, Washout, ...6.0164

WAVE GENERATION ...British West Indies, Profiles, Shear, Towers, Wind-water Interaction, ...2.0103

SEA-AIR INTERACTION RESEARCH ...Acoustical, Heat and Radiation Transfer, Hydrodynamics, Salinity, ...3.0039

SHALLOW WATER ACOUSTIC PROPAGATION STUDIES (SWAPS) ...Acoustical, Geomorphology-topography, Liquids, Subbottom, Thermal, Transmission, Turbulence - Sea Water, Water Motion, ...1.0065

PHYSICAL OCEANOGRAPHY ...Surface Environments, Temperature, Transmission, Velocity, ...1.0026

INTERNAL WAVE RESEARCH ...Acoustical, Surface Environments, Tides, Waves-internal, ...2.0096

SHIP DESIGN WAVE RESEARCH ...Operational Aspect, Other-design-and-construction, ...8.0291

SHALLOW WATER OCEANOGRAPHY ...Continental Shelf, Environmental Effectssgeologic, Forecasting-prediction, Pressure, Subsurface Environments, ...1.0172

NUMERICAL WAVE PREDICTION ...Development of Models, Forecasting-prediction, Model Studies, Numerical Analysis-other, ...2.0104

WAVE FORCES ON BREAKWATERS ...Breakwaters, Ext Pressure on Struct-general, Shoreline Structures, Wave Action, ...8.0234

STABILITY OF RUBBLE-MOUND BREAKWATERS ...Breakwaters, Design Criteria, Engineering Structures-general, Hydrodynamics, Shoreline Structures, Wave Action, ...8.0045

HARBOR DESIGN STUDIES ...Harbors, Navigation, ...8.0046

GREAT LAKES RESEARCH - LAKE WAVES ...Great Lakes-general, Shear, Water Motion Recorders, Wind-water Interaction, ...2.0118

MECHANICS OF WAVE ACTION IN DEEP AND SHALLOW WATER ...Currents-longshore, Geomorphology-topography, Sand Bars, Tsunami, Waves-internal, ...2.0100

WAVE ACTION ON STRUCTURES ...Engineering Structures-general, Hydrodynamic Structures, Models, Shoreline Structures, Stability, Wave Action, ...8.0175

MECHANICS OF SAND MOVEMENT BY WAVES ...Model Studies, Ocean Waves - Currents, Shoreline Structures, Size, Wave Motion in Fluids-other, ...7.0217

CORRELATION OF BEACH PROPERTIES AND INCIDENT WAVES ...Beach, Development, Engineering Structures-general, General Transport Effects, Sea Level Variations, Shoreline Structures, ...8.0204

HYDRAULICS AND DYNAMICS OF ESTUARIES ...Erosion-general, Estuaries, Flow Characteristics -water, Sedimentation, Sedimentology-general, Water Level Fluctuation, ...7.0102

WAVE RECORDING AND ANALYSIS ...Data Reduction and Analysis, Lasers-masers, Pressure, Radar, Sonar, Statistics-general, Water Motion Recorders, ...2.0101

RUBBLE-MOUND PROTOTYPE STUDIES ...Breakwaters, Jetty, Shoreline Structures, Water Motion Recorders, Wave Action, ...8.0042

NUMERICAL SIMULATION OF HYDRODYNAMIC PHENOMENA BY DIGITAL COMPUTER ...Groundwater, Model Studies, Open Channel Flow, Porous Media - Flow Through, Subsurface Flow, ...4.0083

STUDY ASSOCIATION BETWEEN TRADE WIND SYSTEM AND NORTH PACIFIC OCENAOGRAPHIC CLIMATE ...Hawaii, Meteorological Studies, Ocean-lakes, Temperature, Wind-water Interaction, ...3.0019

Waves-internal

OCEAN CIRCULATION STUDIES ...Acoustical, Atlantic Ocean-north, Currents-ocean, Hydrodynamics, Statistics-general, Water Motion Recorders, ...2.0040

OCEAN WAVES ...Model Studies, Profiles, Temperature, Waves, Wind-water Interaction, ...3.0004

WAVES ...Pacific Ocean-north, Thermal, Waves, ...2.0097

MARINE HYDRODYNAMICS ...Antarctic Ocean, Circulation-general, Laboratory Analysis, Model Studies, Waves, ...8.0196

CIRCULATION AROUND OCEANIC ISLANDS ...Circulation-general, Density, Islands, Mixing, Thermodynamics, Wind-water Interaction, ...2.0010

SEDIMENT-FLUID INTERACTIONS ...Flow of Dispersed Solids, Geomorphology-topography, Sedimentation, Textures-structures, Wave Action, ...7.0245

OCEANIC INTERNAL MOTIONS AFFECTING OPERATIONS ...Bermuda, Buoys, Military Aspects, Thermal, Water Motion Recorders, ...2.0115

OCEAN DYNAMICS EXPERIMENTS ...Atlantic Ocean-north, Buoys, Currents-ocean, Operational Aspect, Thermal, ...2.0071

FIELD DETECTION AND MEASUREMENT OF INTERNAL WAVES ...Acoustical, Density, Digital Computer Applications, Temperature, Tides, ...2.0125

INTERNAL WAVE STUDY ...Acoustical, Atlantic Ocean-north, Continental Shelf, Thermal, Tides, ...2.0099

THERMAL WAKE STUDIES ...Physical Analysis, Thermal, Thermocline, Turbulence - Sea Water, ...1.0174

FUNDAMENTAL PROBLEMS IN HYDRODYNAMICS ...Convection, Hydrodynamics, Ordnance, Survey Studies, Waves, ...2.0102

OCEANOGRAPHIC RESEARCH - INVESTIGATIONS WITH THERMISTOR CHAIN ...Acoustical, Forecasting-prediction, Temperature, Thermal, Transmission, Water Properties-general, ...1.0143

INTERNAL WAVE STUDIES ...Acoustical, Model Studies, Refraction, Scattering, Surface Environments, ...1.0021

INTERNAL WAVE RESEARCH ...Acoustical, Surface Environments, Tides, Waves, ...2.0096

DIVER-ASSISTED OCEANOGRAPHY ...Benthonic-bottom, Continental Shelf, Currents-bottom, Diving and Scuba, Geomorphology-topography, Mapping, ...4.0098

MECHANICS OF WAVE ACTION IN DEEP AND SHALLOW WATER ...Currents-longshore, Geomorphology-topography, Sand Bars, Tsunami, Waves, ...2.0100

Wax, Paraffin

EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE ...Creosote, Fouling, Isopods, Petroleum Cpds. -non-specific, Preservatives, Wood Preservatives-non-specif, ...8.0198

Weather - Physical Properties

Energy-radiation

Energy-general

SEA BREEZE INVESTIGATION ...Data Analysis - General, Gulf of Mexico, Heat and Radiation Transfer, Land-sea Breezes, Texas, ...3.0040

Heat Budget

MESO AND CONVECTIVE SCALE SYSTEMS IN THE MARITIME TROPICAL ATMOSPHERE ...Air Motion-general, Convection, Islands, Meteorologic Model Studies, Tropic, ...3.0062

WEATHER PROGRAM - STATION T-3 ...Arctic Ocean, Drift Stations, Energy Exchange Processes, Patterns, Physical Climatology, Weather Forecasting, ...3.0060

CLIMATE CHANGE OVER THE POLAR OCEAN ...Arctic Ocean, Heat and Radiation Transfer, Numerical Analysis-other, Physical Climatology, ...3.0058

ATMOSPHERIC-OCEANIC-GLACIOLOGIC INTERACTIONS IN THE ANTARCTIC ...Antarctica, Boundary Layer Studies, Heat Exchange, ...3.0009

LARGE-SCALE ATMOSPHERIC EVOLUTION ...Heat and Radiation Transfer, Heat Exchange, Meteorologic Model Studies, Meteorological Studies, Weather Forecasting, ...4.0043

ANALYSIS AND INTERPRETATION OF SATELLITE RADIATION DATA ...Atmosphere Radiation, Meteorologic Model Studies, Radiation Balance, Radiation-general, Satellites, ...4.0009

Heat Exchange

RESEARCH ON DYNAMICS OF LOW LATITUDE CIRCULATIONS ...Convection, Meteorological Studies, Patterns, Shear, Tropical Cyclones, ...3.0050

TRITIUM IN HURRICANES ...Aircraft, Heat and Radiation Transfer, Particle-gas Transfer, Tracers, Tritium, Tropical Cyclones, ...3.0047

INFRARED RADIOMETRY FOR SURFACE HEAT FLOW ...Atmosphere Radiation, Heat and Radiation Transfer, Infrared Radiation, Technique Development, Temperature, ...4.0153

ARCTIC AIR, SEA AND ICE ...Arctic, Climatography, Heat and Radiation Transfer, Micrometeorology, Sea Ice, Weather Forecasting, ...3.0088

AIR-SEA INTERACTION ...Latent Heats, Temperature, ...3.0041

ATMOSPHERIC-OCEANIC-GLACIOLOGIC INTERACTIONS IN THE ANTARCTIC ...Antarctica, Boundary Layer Studies, Heat Budget, ...3.0009

RADIANT ENERGY FLUX ACROSS THE AIR-SEA INTERFACE AND HEAT BUDGET OF THE OCEANS ...Air-sea Boundary-general, Forecasting-prediction, Heat and Radiation Transfer, Radiation-general, Thermal, ...3.0032

TURBULENCE OVER WAVES ...Forecasting-prediction, Heat and Radiation Transfer, Meteorological Studies, Thermal, Turbulence, Waves, ...3.0027

LARGE-SCALE ATMOSPHERIC EVOLUTION ...Heat and Radiation Transfer, Heat Budget, Meteorologic Model Studies, Meteorological Studies, Weather Forecasting, ...4.0043

ATMOSPHERIC TURBULENCE FIELD STUDIES ...Air Motion Instruments, Air-sea Boundary-general, Boundary Layer Studies, Turbulence, Velocity, ...3.0020

ANALYSIS OF THE MARINE LAYER - A MESO METEOROLOGICAL STUDY ...Air-sea Boundary-general, California, Diffusion, Orographic Effects, Turbulence, ...3.0001

Latent Heats

AIR-SEA INTERACTION ...Heat Exchange, Temperature, ...3.0041

Radiation-general

RADIANT ENERGY FLUX ACROSS THE AIR-SEA INTERFACE AND HEAT BUDGET OF THE OCEANS ...Air-sea Boundary-general, Forecasting-prediction, Heat and Radiation Transfer, Heat Exchange, Thermal, ...3.0032

REFLECTIVITY AND EMISSIVITY STANDARDS ...Atmosphere Radiation, Infrared Radiation, Interferometry, Radiation, Standards, Specifications, ...4.0142

RELATION OF SATELLITE DATA TO LARGE SCALE ATMOSPHERIC CIRCULATION AND ENERGETICS ...Anticyclones-cyclones, General Movement, Patterns, Satellites, Weather Charts-maps, ...4.0143

ANALYSIS AND INTERPRETATION OF SATELLITE RADIATION DATA ...Atmosphere Radiation, Heat Budget, Meteorologic Model Studies, Radiation Balance, Satellites, ...4.0009

Radiation-terrestrial

MICROWAVE RADIOMETER DEVELOPMENT ...Instrumental Services, Microwave Radiation, Microwave Techniques, Radiation Detection, Wave Form, ...8.0056

GREAT LAKES RESEARCH - ICE CHARACTERISTICS ...Aerial Photography, Lake Superior, Micrometeorology, Origin, Petrofabrics, Sea Ice, ...3.0082

Sunshine

ATMOSPHERIC EFFECTS ON INCOMING SOLAR RADIATION OVER TROPICAL OCEANS ...Cloud Cover, Development of Models, Humidity, Pacific Ocean-general, Tropic, ...3.0036

HYDROGRAPHY OF APPALACHEE BAY ...Bays, Currents-ocean, Rain-general, Salinity, Temperature, ...1.0147

Temperature

THE PROPAGATION OF ACOUSTIC WAVES IN THE STRATIFID ATMOSPHERES ...Acoustics, Transmission, Waves, Wind-general, ...1.0059

AIR-SEA INTERACTION ...Heat Exchange, Latent Heats, ...3.0041

EVALUATION OF LOW LEVEL TEMPERATURE GRADIENTS OVER THE LINE ISLANDS NEAR THE EQUATOR ...Atmosphere Radiation, Line Islands, Radiation Balance, ...1.0180

VERTICAL CURRENT STRUCTURE IN THE GREAT LAKES ...Circulation-general, Great Lakes-general, ...2.0033

PHYSICAL OCEANOGRAPHY ...Surface Environments, Transmission, Velocity, Waves, ...1.0026

Thermodynamics

APPLICATION OF METEOROLOGICAL SATELLITE SENSING TO GENERAL CIRCULATION MODELS ...Infrared Radiation, Meteorologic Model Studies, Particle-gas Transfer, Patterns, Satellites, Weather Forecasting, ...4.0137

ENERGY TRANSFER NEAR THE EARTHS SURFACE ...Air Motion Instruments, Buoys, Heat and Radiation Transfer, Turbulence, ...3.0044

EXPERIMENTAL FLUID DYNAMICS ...Laminar - Turbulent, Model Studies, Rotating Fluids, Shear-flow, Wind-water Interaction, ...3.0021

General Synoptic Observations

AN EXPERIMENTAL AND THEORETICAL STUDY OF THE MARINE AND CONTINENTAL CLIMATES OF POINT CONCEPTION TO THE MORRO BAY REGION OF CALIFORNIA ...California, Micrometeorology, Military Aspects, Shoreline - Coastline, ...3.0055

EVALUATION OF LOW LEVEL TEMPERATURE GRADIENTS OVER THE LINE ISLANDS NEAR THE EQUATOR ...Atmosphere Radiation, Line Islands, Radiation Balance, Temperature, ...1.0180

EXCHANGE METEOROLOGIST WITH JAPANESE ANTARCTIC RESEARCH EXPEDITION ...Air-sea Boundary-general, Antarctic Ocean, Mixing, Radiosonde, Sea Ice, ...3.0013

LINE ISLANDS EXPERIMENT ...Boundary Layer Studies, Line Islands, Physical Climatology, Satellites, Wind-water Interaction, ...3.0063

HEAT AND MOMENTUM EXCHANGE PROCESSES BETWEEN THE OCEAN AND THE ATMOSPHERE ...Heat and Radiation Transfer, Meteorological Studies, Oregon, Pacific Ocean-east, Wind-water Interaction, ...3.0038

OCEAN WIND WAVE GENERATION AND DISSIPATION ...Buoys, North Sea, Velocity, Waves, Wind-water Interaction, ...2.0105

SEA USE ...Marine Biology, Oceanography-general, Pacific Ocean-east, Platforms, Seamounts-guyots, ...7.0303

SEVERE STORM CLIMATOLOGY ...Patterns, Tropical Cyclones, ...3.0054

RESEARCH FLIGHT FACILITY ...Aircraft, Equipment Purchase Operation, Technique Development, Tropical Cyclones, ...4.0158

FISHERY FORECASTING - TEMPERATE FISHERIES ...Circulation-general, Low Temp. -but Above 32f, Pacific Ocean-east, Temperature, ...5.0197

MESOSCALE WIND SYSTEMS AROUND THE GREAT LAKES ...Lake Michigan, Land-sea Breezes, Meteorologic Model Studies, Patterns, Pollution Behavior-general, ...3.0064

Humidity

AN INVESTIGATION OF TRITIUM IN RAIN WATER ...Atmosphere Composition, Particle-gas Transfer, Precipitation-other, Rain-other, Tritium, ...1.0130

AIR-SEA INTERACTION ...Heat Exchange, Latent Heats, Temperature, ...3.0041

AIRBORNE SEA SURFACE MEASUREMENTS IN THE EQUATORIAL PACIFIC ...Atolls, Infrared Radiation, Mapping, Oceanic Fronts, Radiation Detection, Temperature, ...1.0190

ATMOSPHERIC EFFECTS ON INCOMING SOLAR RADIATION OVER TROPICAL OCEANS ...Cloud Cover, Development of Models, Pacific Ocean-general, Sunshine, Tropic, ...3.0036

HUMIDITY STANDARDS AND MEASUREMENTS ...Evaporation, Humidity Instruments, Pressure-density, Standards, Specifications, Streams, ...8.0081

EVAPORATION OF WATER ...Evaporation, Humidity Instruments, Particle-gas Transfer, ...3.0012

Optics

Visibility

VISUAL RANGE METERS ...Distance-measuring-device, Fog-haze-mist, Guidance, Landing, Meteorological Conditions, ...8.0072

MISCELLANEOUS SERVICES FOR FEDERAL AVIATION AGENCY (VISUAL RANGE) ...Air-sea Boundary-general, Distance-measuring-device, Fog-haze-mist, ...3.0011

Pressure-density

EXPERIMENTS IN AIR-SEA INTERACTION INVOLVING SURFACE PRESSURE MEASUREMENTS ...Air Motion-other, Wind-other, Wind-water Interaction, ...3.0017

WAVE GENERATION BY THE TURBULENT WIND FIELD OVER THE SEA ...Platforms, Turbulence, Velocity, Waves, Wind-water Interaction, ...3.0008

EASTERN BOUNDARY CURRENTS ...Mixing, Ocean Currents-other, Wind-general, Wind-water Interaction, ...2.0026

HUMIDITY STANDARDS AND MEASUREMENTS ...Evaporation, Humidity, Humidity Instruments, Standards, Specifications, Streams, ...8.0081

TROPICAL ANALYSIS AND FORECASTING ...Filtering Theory, Mathematical Analysis, Meteorologic Model Studies, Tropic, Weather Forecasting, ...3.0061

GREAT LAKES RESEARCH - HARBOR CURRENTS ...Great Lakes-general, Harbors, Model Studies, Ocean Currents-other, Water Level Fluctuation, Wind-water Interaction, ...2.0074

Weather Charts-maps

RELATION OF SATELLITE DATA TO LARGE SCALE ATMOSPHERIC CIRCULATION AND ENERGETICS ...Anticyclones-cyclones, General Movement, Patterns, Radiation-general, Satellites, ...4.0143

Weather Display Systems

WEATHER ANALYSIS AND FORECASTING TECHNIQUES ...Meteorological Studies, Weather Forecasting, ...4.0045

NUMERICAL PREDICTION ...Computer Applications, Data Reduction and Analysis, Meteorological Studies, Prediction, Weather Forecasting, ...4.0041

Weather Forecasting

APPLICATION OF METEOROLOGICAL SATELLITE SENSING TO GENERAL CIRCULATION MODELS ...Infrared Radiation, Meteorologic Model Studies, Particle-gas Transfer, Patterns, Satellites, Thermodynamics, ...4.0137

UTILIZATION OF SYNCHRONOUS SATELLITE DATA ...Height - Ceiling, Patterns, Satellites, Technique Development, Velocity, ...4.0173

ARCTIC AIR, SEA AND ICE ...Arctic, Climatography, Heat and Radiation Transfer, Heat Exchange, Micrometeorology, Sea Ice, ...3.0088

WEATHER PROGRAM - STATION T-3 ...Arctic Ocean, Drift Stations, Energy Exchange Processes, Heat Budget, Patterns, Physical Climatology, ...3.0060

AIR-SEA INTERACTION ...Air-sea Boundary-general, Currents-ocean, Gulf of Mexico, Thermal, Tropical Cyclones, ...3.0042

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THE NATIONAL COUNCIL ON MARINE RESOURCES AND ENGINEERING DEVELOPMENT

The National Council on Marine Resources and Engineering Development was established within the Executive Office of the President in June, 1966, under Public Law 89–454, which declared it to be "the policy of the United States to develop, encourage, and maintain a coordinated, comprehensive, and long-range national program in marine science for the benefit of mankind to assist in protection of health and property, enhancement of commerce, transportation and national security, rehabilitation of our commercial fisheries, and increased utilization of these and other resources."

The Act provided for a cabinet-level Council composed of heads of those departments and agencies having statutory missions to engage in oceanographic research and exploration, and it designated the Vice President to serve as chairman. The duties of the Council established by the Act are to assist and advise the President to:

(1) survey all significant marine science activities, including the policies, plans, programs, and accomplishments of all departments and agencies of the United States engaged in such activities;

(2) develop a comprehensive program of marine science activities, including but not limited to exploration, description and prediction of the marine environment, exploitation and conservation of the resources of the marine environment, marine engineering, studies of air-sea interaction, transmission of energy, and communications, to be conducted by departments and agencies of the United States, independently or in cooperation with such non-Federal organizations as States, institutions and industry;

(3) Designate and fix responsibility for the conduct of the foregoing marine science activities by departments and agencies of the United States;

(4) insure cooperation and resolve differences arising among departments and agencies of the United States with respect to marine science activities under the Act, including differences as to whether a particular project is a marine science activity;

(5) undertake a comprehensive study, by contract or otherwise, of the legal problems arising out of the management, use, development, recovery, and control of the resources of the marine environment;

(6) establish long-range studies of the potential benefits to the United States economy, security, health, and welfare to be gained from marine resources, engineering, and science, and the costs involved in obtaining such benefits;

(7) review annually all marine science activities conducted by departments and agencies of the United States in light of the policies, plans, programs and priorities developed pursuant to this Act;

(8) coordinate a program of international cooperation in work done under the Act, pursuant to agreements made by the President with the advice and consent of the Senate;

(9) prepare a report, as assigned by the President, to be transmitted to the Congress in January of each year which shall include (1) a comprehensive description of the activities and the accomplishments of all agencies and departments of the United States in the field of marine science during the preceding fiscal year, and (2) an evaluation of such activities and accomplishments in terms of the objectives set forth pursuant to the Act.

Under the National Sea Grant College and Program Act of 1966, P.L. 89–688, the Council was assigned the additional responsibilities, as the President may request, to: (1) advise the National Science Foundation with respect to policies, procedures, and operations of the Foundation under the Act; (2) provide policy guidance to the Foundation with respect to contracts or grants in support of the program; and (3) submit an annual report on its activities and recommendations on this program to the Speaker of the House of Representatives, the Committee on Merchant Marine and Fisheries of the House of Representatives, the President of the Senate, and the Committee on Labor and Public Welfare of the Senate.